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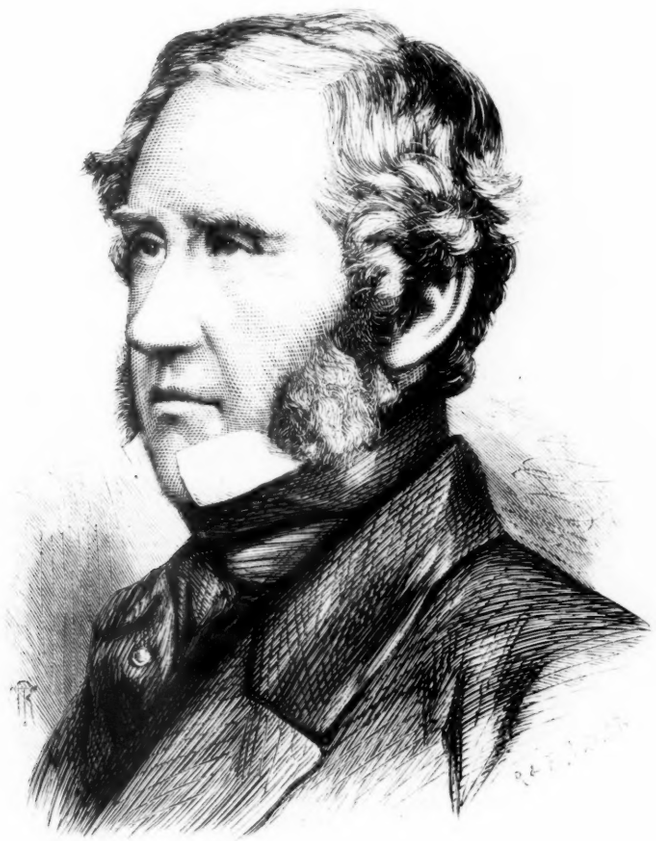


LORD PENRHYN.
(Owner of the great Slate Quarries of Penrhyn.)

THE INDUSTRIES OF NORTH WALES.

BEYOND the development and production of its natural resources, North Wales has but few, if any, industries of particular consequence. Among the mineral resources of the country are slate, lead, iron and copper, the first named being by far the most important; and in the series of papers which we propose upon the "Industries of North Wales," we shall first treat upon the slate quarries.

The slate deposits of North Wales are confined to Carnarvonshire and Merionethshire. The beds in the two shires differ much from each other, and may well be considered as two distinct systems. The direction of the two beds is as follows:—Beginning with Carnarvonshire, we find the first traces of the vein in the north-east portion of the county, at a place called Aber. From here the general direction of the vein is towards the south-west, and following this direction, we next find the vein at Llanllechid, where, after crossing the river Ogwen, it forms the bulk of the Elidir mountain, the Penrhyn quarries being upon one side of the mountain, and the Llanberis quarries upon the other. From thence it proceeds tortuously to the Nantlle vale, and is finally found traversing the Pennant Valley, and it reaches the sea-shore at Mynydd Ednyfed, near Criccieth. The Merionethshire system commences at Dolyddelen and Penmachno, in the frontiers of Carnarvonshire, from whence it travels in a south-westerly direction to Festiniog, in the northerly portion of Merionethshire. The vein is again found in the southern portion of the shire; but between these two districts there is an inroad of a different stratum of rock. Between Barmouth and Harlech there runs inwards towards the Arenig Mountain a range of Lingula flags, containing many traces of the system of the Eryri Mountain. Indeed, fragments of the Carnarvonshire slates have been found in this barrier. Southward of it, we first find the slate vein at Dinas Mowddwy, and proceeding south-easterly, we can follow the veins through Aberllefeni, Corris and Aberganolwyn, to the district of Llanfihangel-y-Pennant.

The transverse inclination of the vein is towards the north-west; that is, it sinks towards the south-east. In the Carnarvonshire district the inclination of the slate-vein is 25° from being perpendicular, and the cleavage of the slate is usually

perpendicular, or nearly so. In the Merionethshire system the inclination varies from 25° to 30° from being horizontal, while the cleavage is in the same direction, but at an angle of 60° from being horizontal. There is a difference in the colours of the slates. Carnarvonshire slates are blue with a slight tinge of red, purple, red and light green. But the Merionethshire slates are of an uniform blue-grey tinge, with a slight variation in some places towards a darker shade of blue. There are various methods of working a quarry, depending entirely upon the nature of the ground, where the deposit occurs. When the veins appear in the side of a hill, and the cleavage of the vein coincides with the slope of the mountain, the quarry is worked in a system of open galleries or terraces. There are many advantages connected with this system of working. The blocks and rubbish are easily removed to the foot of the hill, and there is no necessity for pumping as in those we shall describe again. When the vein sinks vertically into the mountain-side or below the level of the valleys between, the quarry takes the form of a pit, and has the obvious disadvantage of being obliged to incur the cost of hoisting machinery and of pumping. Moreover, the sides of the pit are continually becoming loose and falling into the pit, often with fatal results to the workmen below, and always obstructing the labour more or less, and causing an extra addition to the working expenses. The great quarries of Penrhyn and Llanberis have the advantage of being worked in open galleries. Those of Nantlle are, however, pits or sinkings.

There is another system of working, namely, in underground tunnelling. This occurs when the vein recedes into the heart of the mountain, and the expense of removing the overlying strata would be too great. In this case, levels or tunnels are driven into the vein, and then chambers are excavated in the slate alternately, with pillars of slate rock left to support the roof. This system is used throughout Merionethshire, except in rare instances where the nature of the ground permits the quarry to be worked in open terraces. It is apparent that there are numerous disadvantages connected with the system of working under cover; for, besides the want of clear daylight to see how to work the rock to the best advantage, and the difficulty of properly ventilating the works, a large portion of the valuable rock is wasted in leaving supports for the roof of the excavations.

It will be understood that veins of various descriptions run continuously side by side, being separated from each other in the Merionethshire district by a layer of hard trap rock, or a conglomerate of the slate and trap rock in some instances; and in Carnarvonshire by narrow veins or ribbons of hard rock (sometimes so small that they are mere *cropas* or open seams in the rock); and also in one instance by a thickness of whinstone.

In the slate veins there are various impurities or imperfections. Notably among these are the greenstone dykes, which penetrate the slate in various directions. Somewhat similar are the spar veins, which also destroy the slate vein, but the latter very generally appears as a layer upon the vein. Both of these agencies destroy the quality of the slate rock for many yards on either side of their course, and often squeeze the vein into a very small compass. In the slate-rock itself there are various joints. The two great disectors are called "cropas" and "slants." The cropa coincides with the stratification of the rock. The slants, on the other hand, are divisions which often occur diagonally to the plane of stratification; in fact, no general direction can be given to the slants. Among the smaller joints, there are three varieties, viz., foot or floor-joints, back-joints and bevel-joints. The names of these joints will explain to the reader their nature. The floor-joints are those which are at right angles with the cleavage, and which usually form the floor for the men to work upon. The back-joints are vertical joints at right angles to the floor-joints. The bevel-joints are also vertical, but they occur diagonally with the floor-joints. When these joints occur in favourable numbers, they tend greatly to the success of a quarry. Too many of them cause the slate to be only obtainable in blocks too small for any purpose, while the absence of them causes much labour in blasting the rock. There is one other fault which we must mention in order to complete our prefatory narrative—this is termed a "slip." The slate-veins vary in thickness at different places, according to the pressure upon them, and in some places, after proceeding for some distance in a certain direction, are found to be thrown out of their course—the line in which the veins are removed out of their course being termed the "fault." These faults vary from a few inches to many miles in extent.

The blocks after having been hewn from the quarry are split lengthwise with wedges, and crosswise either by sawing machines or by being struck with a mallet, after a notch has been made in the slab with a chisel. After the blocks are reduced to a suitable size they are split into plates for roofing purposes with a thin chisel three or four inches wide. The force of a small mallet is sufficient to do this. They are further dressed or squared into sizes with a hand-slate knife, or with a machine for that purpose. The use of machinery in sawing or dressing slates depends entirely upon their texture. Slates of a soft nature are treated profitably with machinery; but when they are hard or "sharp," as it is termed, the use of machinery is not so favourable. In the use of dressing-machines, when the slate is sharp, the machine usually makes a serrated edge instead of cutting the slate regularly. There is, however, a treddle machine, in which the men can so regulate the stroke that it to a great extent removes the difficulty. There are various plans of dressing engines propelled by steam or water-power. The first plan offered was that in which the blade descended perpendicularly. In every case the action of the blade should be oblique or the slate would be shattered. Following this came a machine with an alternate circular action. Two blades were fixed obliquely to the circumferences of two wheels. After the blade descended on one side, the motion became reversed, thus keeping two men employed. This machine was, no doubt, an improvement upon the first machine, but there was one fault common to both—they did not work smoothly enough. The action was too sudden or "jerking." Then there was introduced a machine similar to the last-mentioned, excepting that its action was single. This machine, the patent of J. W. Greaves, Esq., the proprietor of one of the largest quarries in Festiniog, was found to work kindly, and suited the nature of the slates admirably.

The machines for sawing crosswise are all of them constructed much upon the same principle. One, embodying many conveniences, has been patented by Mr. Griffith Owen, of the Union Iron Works, Portmadoc. There are also other machines upon the same general basis. The plan of these machines is in brief as follows:—The slabs are placed upon a large iron table, in the centre of which there is a circular saw. The board travels at a regulated speed against the saw. There is, however, a description of machine for sawing hard blocks patented by Mr. Hunter. The individuality of this machine consists in the saw, the teeth of which are separate from the body of the tool. The teeth are small circular pieces of steel, three quarters of an inch in diameter. This plan works admirably with very hard rocks, which could not otherwise be cut evenly. There are some qualities of rock which can be split crosswise with the mallet, evenly; and those broken up in this fashion offer a better grain for the purpose of being split up into plates.

Besides roofing slates, the slate-rock is also rendered into slabs for the purpose of making cisterns, billiard-tables, &c. For this purpose the surface of the slab is planed by machinery. The slabs are laid upon the table of the machine, and a broad chisel, firmly fitted in a frame-work above the table, is propelled along the table, taking a thickness off the slab as it proceeds, and leaving a clean surface behind it. The blade can be directed on any side of the table by means of a screw. Mr. Robert Hughes, of Aberllefeni Slate Quarry, has invented a new machine, in which two blades work, one taking a thickness from the slab after the other. The blades also traverse a beam erected above the table.

While speaking of machinery we may mention two kinds of instruments used in boring the rock in the quarries. Neither of these has as yet made much progress in the quarries; but each of them would appear to have many points in its favour. The first we shall mention is Burleigh's rock-drill. This instrument imitates the action of the workmen in thumping with the long chisel. There is a small steam cylinder fitted to a tripod, which impels a chisel with great rapidity—the stroke being about four and a-half inches—the chisel turning continually. Steam is conveyed to the drill in pipes connected with the machine room. The instrument can be made to work in any direction, by a system of joints, and will bore in the slate-rock more than thirty feet per day. It will also pump the drill-hole dry as it proceeds. The other machine we have to notice is Dixon's patent drill. This machine is worked by manual labour. It consists of a long cylinder which, as it rotates, is urged forward gradually by means of a screw. The drill is fitted into the end of the cylinder, and bores a hole three or four inches in diameter. The chief peculiarity of this machine is that it has a pump attached to the outer end of the cylinder. The water is forced through and issues from the point of the drill, thus keeping the drill-hole free from all rubbish. A charge of twenty-five pounds of powder can be placed in the holes bored by this machine. The object of using such a considerable charge is to loosen the rock in large blocks. The smaller charges loosen only a small quantity of rock and often break it up into very diminutive fragments.

The workmen are divided into classes—rockmen, slate-dressers, and rubbellers—rubbish carriers or labourers. The rockmen blast the rock in the quarry and the dressers split up the blocks and make slates from them. One rockman and two slate-dressers form a partnership, the former being generally able to

supply enough blocks to keep the other two busily engaged. The pay being according to the number of slates produced, the receipts are divided among the three partners. In Carnarvonshire the men exchange duties periodically, but in the Merionethshire quarries they always follow up the same department. The wages of these men average from one pound to thirty shillings weekly. Unskilled workmen earn the minimum rate, but the majority obtain a medium wage. The men enter into contracts or bargains with the agent. When there is a poor prospect of obtaining slates, when paid by the produce, they receive a premium, in order to put them in a position to earn a standard rate of wages. The rubbellers who carry away the rubbish from the quarry are paid by the ton, their pay averaging about eighteen shillings per week. The wages throughout the quarries are paid every four weeks. This system of monthly payment obliges the workmen to buy goods upon credit, and it is felt by those who study the habits of the people, that a system of shorter payments would greatly conduce to the prosperity of trade and indeed to some extent to the morality of the people, for debt is a relentless demoralizer.

The following is a recapitulation of the sizes of roofing slates, and the names by which they are known :—

Queens	.	.	28 in. to 36 in. long ; width varies.		
Empresses	.	.	26 in.	×	16 inches.
Princesses	.	.	24 „	×	14 „
Duchesses	.	.	24 „	×	12 „
Small do.	.	.	22 „	×	12 „
Marchionesses	.	.	22 „	×	11 „
Countesses	.	.	20 „	×	10 „
Wide do.	.	.	18 „	×	10 „
Viscountesses	.	.	18 „	×	9 „
Wide ladies	.	.	16 „	×	10 „
Ladies	.	.	16 „	×	9 „
Small ladies	.	.	14 „	×	8 „
Ditto	.	.	14 „	×	7 „
Doubles, large	.	.	13 „	×	7 „
Doubles	.	.	13 „	×	6½ „
Ditto, small	.	.	12 „	×	6 „
Singles	.	.	11 „	×	5½ „
Headers	.	.	14 „	×	12 „
Ditto	.	.	14 „	×	10 „

Rough heavy slates are also produced, called Welsh rag.

The quality of the slate can easily be detected in the colour and also by the sound produced by striking the slate. The darkest shades of colour always denote a texture too soft to last. Slates of this colour often look exceedingly beautiful when first made ; they split cleanly, and their grain is of a silky nature, but when exposed to the weather for some time they crumble into fragments. Slates of this quality are not more sonorous than a sheet of lead. Again, slates of the lightest shades of colour are generally of too stony a nature to be very valuable. They are not capable of being split up into the thinnest description of roofing slates. The ring of these hard slates is clear and cold. The best quality of slates is of medium colour, the cleavage is even, and the plate free from contortions, and rings when struck with a full sonorous sound, in some degree similar to the sound produced from a sheet of wrought-iron. Slates of this quality can be split up into exceedingly thin plates, and are even to some degree pliant. The general failing of the Carnarvonshire slates is that of being too hard ; whilst in Merionethshire the tendency is towards being too soft. We do not attempt to compare the qualities of the two districts. The best qualities of either sort are excellent. Perhaps we may safely venture to say that the very hard slates of Carnarvonshire have a decided advantage over the soft Merionethshire slates in being more durable. In fact beyond the increased expense of their production and their unfitness to be hewn into plates of the thinnest descriptions, the very hardest slates are not so very much inferior to those of the best quality ; their great durability is much in their favour.

Having now cleared our path, we shall in our next paper describe the quarries individually, commencing with the Llanberis Quarry, one of the largest in North Wales.

CRYSTALLIZED SUGAR.

MESSRS. FINZEL'S SUGAR REFINERY, BRISTOL.

SUGAR has held so prominent a place this year, not only in legislation, but also in the exhibition of scientific appliances for manufacture, that a short account of the operations carried on at the largest refinery in England may not be without interest.

The importation of sugar of all kinds into the United Kingdom last year amounted to nearly sixteen million hundredweights, of which about fourteen and a-half millions were entered for home consumption. Of this quantity 5,224,470 cwt. came from British possessions : 3,091,275 cwt. from the Spanish West India Islands ; 1,878,587 cwts. from Brazil ; 2,238,811 cwt. from France ; 341,816 cwt. from Germany.

It will thus be seen that the larger quantity consisted of raw sugar, much of which had to be converted here into the refined, or loaf sugar, of commerce, or into that brilliant, pure crystallized form of the special manufacture of which in the factory devoted to its production, we design to give some account.

For it must be remembered that the ordinary lump sugar is by no means the purest form in which this "sweetener of every cup" is presented as an article of manufacture, however superior the white sparkling product of loaf sugar may be to the best of the raw sugars from which it is produced. To say nothing of the intermixture of beet, which is so frequently used in the common loaf, the process of refining cane sugars seems to require some further operation in order to complete it, and, as it were, to concentrate the saccharine to the exclusion of other properties.

Very great improvements, however, have taken place in the whole method of refining, and machinery and apparatus have undergone changes which have effected a reformation in this branch of our manufactures.

It only needs to examine the bulk of raw sugars which are sent here from the plantations to see what processes must necessarily be used in order to render them acceptable articles of diet, while an inspection of samples under the microscope still further proves that even refining should be carefully and thoroughly conducted if we are to reduce the saccharine mass to a condition of purity.

For, what is known as raw sugar, differing as it does in degree of strength and fineness, is composed of elements which, though they may be desirable when the juice is newly expressed from the cane, and possesses direct dietetic qualities, are certainly objectionable after the sugar has been shipped when fermentation is so easily set up.

The newly expressed juice contains water, sugar, gum, green fecula, extractive gluten, acetic and malic acids, acetates of lime and potash, supermalate and sulphate of lime, and lignin. The object of refining sugar is to remove some at least of these substances, which not only dispose the mass to fermentation, but which also prevent its being crystallized, and thus reduced to a completely pure saccharine substance.

In addition to these matters, however, the ordinary or moist sugar abounds with a parasite—the Acarus Sacchari—an insect which can of course only be detected under a good microscope, but which has the revolting appearance of the *pediculus*, and is a little too suggestive to sensitive persons who, having "a sweet tooth," are adverse to the conviction that during a long consumption of ordinary or only partially refined sugar, they have taken into their stomachs a larger number of these creatures than can conveniently be represented by the numeration table.

Even in the refined or loaf sugars of the ordinary kind—and especially where they are composed of the coarse beet sugar, of which a considerable quantity is now consumed—the amount of impurity is very considerable, and the continued use of this sort of sugar is matter for surprise when the utmost degree of refinement is to be obtained by perfect crystallization such as that secured by Finzel's process.

It may be remarked, however, that the canny people of Lancashire and Yorkshire have long ago found out the superior quality of this form of sugar when compared with the "lump," which is to be bought for the same price. By far the larger proportion of the immense output of Messrs. Finzel's factories goes to the north, while in the south and in London it has hitherto been little used, although it is rapidly coming into notice.

The visitor to Bristol, who has pointed out to him the enormous pile of building which occupies nearly the whole of the thoroughfare known as the Counterslip, and covers pretty well two acres of ground, will readily believe, however, that the resources of this great manufactory are sufficient to extend the public appreciation of crystallized sugar. There is something stupendous about the appearance of the street area in front of the building, where drays and waggons constantly come and go, and along the tramways at the main entrance a continuous stream of raw sugar in bags, boxes and hogsheads are going in, while an endless succession of tierces, bags and packages of refined crystals are coming out, like the double procession of bees in a mighty hive.

Indeed, the refinery itself is suggestive of a hive. Its very atmosphere is full of sweetness if not of light, and in the counting-house itself there is a honeyed gush, which prepares us for the operations we are to witness in the many-storied pile of which it forms a part.

This vast building with three tall shafts that are landmarks from the outskirts of the busy city, has only been completed some thirteen years. One portion of it was finished in 1847, and

another in 1859, so that it represents the growth of a business which had been previously established in another but much smaller refinery, occupying part of the present site. This building, which was entirely destroyed by fire, was an ordinary refinery, established some forty years ago by the father of the head of the present firm, the late Mr. Conrad Finzel. It was he who invented the application of centrifugal machines to the separation of crystallized sugar from its syrup, and this with some important improvements in vacuum pans and the general appliances of the factory distinguish the Counterslip refinery and its products.

Some indication of the extent of the works is afforded to the visitor, who, having passed through the various general offices, the cashier's department, the sale-rooms, and the sampling room, where raw sugars are inspected and purchased, is asked to inspect the engine-room and the boiler-house. The former department contains the two most powerful out of about thirty steam-engines, which are necessary to sustain the motive power of the establishment, and are at work night and day. In the boiler-house, at the east wing of the building, sixteen out of thirty-one great boilers supply the steam not only for mechanical power, but for all the various processes of the refinery. At the very doors of this boiler-house the yellow tide of the Avon bears the barges of coal, the consumption of which is above 1,000 tons a week; so that the recent enormous increase in the price of coal makes a very serious loss to the firm, who have not, however, raised the quotations of their sugars. Probably the reduction of the duty on raw sugars has just so far recompensed them as to enable them to continue to supply the public on former terms.

But it is time that we began to follow the raw material through the two or three simple stages which turn it into those pure white crystals which from their concentrated saccharine quality are really the perfection of "sugar candy."

In order to do this we must ascend one of the many series of steep or winding staircases which lead to the upper regions of the vast building, and enter the receiving room to which boxes, bags, and hogsheads are raised as soon as they arrive in the area below. There are any great quantities of packages collected here, however, for from the commoner to the finest sorts of sugar (though no low qualities are used) every package is emptied as soon as it reaches the receiving floor. Bags of Mauritius are ripped open, boxes of Havana are staved in, hogsheads of Demerara unheaded, baskets of Java capsized at once, and their contents shot through openings in the timbered floor into one or other of a set of enormous boiling pans.

In these the process commences by reducing the raw sugar to a rather viscid liquid mass, sufficiently fluid to be strained through coarse bags contained in a series of cisterns into which the sticky fluid is allowed to pass. This is the first process of refining, and suffices to remove from the sugar the rougher impurities, so that it may be suffered to escape by means of a pipe in the bottom of each cistern into a great reservoir beneath,—which looks not unlike a big swimming bath, but with a hot moist honeyed atmosphere about it which would satiate even a hungry fly by its inexorable sweetness.

By the old processes some of which are, we believe, retained in a few modern refineries, the sugar which had been reduced to a mass by being boiled in the "blow up" pan was there mixed with a little bullock's blood, or with "finings" made by mixing a solution of alum with lime water, and so producing gelatinous alumina and gypsum. The result of either of these being boiled with the sugar, was the formation of albumen, which, coagulating on the surface of the heated mass, carried with it many of the grosser impurities in the form of scum, which was carefully removed.

By the more careful and complete filtration of the first clarified liquor through deep cylinders containing animal charcoal—these admixtures are rendered unnecessary, and it is this department which may be said to represent the actual refining process that we now have to notice in the Bristol establishment.

In order to see it properly we must ascend by spiral iron staircases through the very core of the building, where amidst a prevailing sense of stickiness, and a general impression that we are taking in saccharine through the pores, we peer through long dim vistas amidst beams and apertures where the immense series of filtering cylinders are reached only by devious galleries or footways. Into these cisterns, which are filled with ground animal charcoal, the sweet viscid brownish fluid is pumped up from the main tank or reservoir into which it has run from the first filtration.

No part of the process requires greater care or more systematic observation than this second fining; and the operation of each separate cylinder is marked and recorded by an ingenious contrivance. From the bottom of every charcoal cistern, a copper pipe is carried to a room where it ends in a tap fixed over a copper trough divided into compartments, so that the pipe representing each filter has, so to speak, a stall and a number of its own. This enables the inspector to judge at once of the purity of the yield of each cylinder, and immediately to detect any imperfection and to trace it to its source.

It may be some indication of the extent of this manufactory to notice, that the ramification of copper tubing for the purpose of conveying the liquid sugar to various departments, would make a length sufficient to reach from Bristol to London, and that the principal "liquor man" has as many as 800 taps under his care. As to the mass of charcoal and the acreage of filtering bags used every week, it is sufficient to say that the steam apparatus for washing and drying the bags, and the furnaces for re-purifying the charcoal for further use, are very considerable adjuncts to the works.

From the charcoal cisterns the clarified liquid sugar, perfectly colourless and with the intense sweetness of honey, runs into a series of cisterns or reservoirs, and thence again is pumped into enormous vacuum pans, some of which are capable of holding from twenty-seven to thirty tons of sugar each, while the two largest (and these are the largest in the world) will turn out respectively 400 and 500 tons of sugar in a week.

It is in these pans that the sugar is crystallized by the evaporation of the moisture and the concentration of the clarified syrup, and this is the process which requires the most attention. At one time the concentration of the syrup was effected by boiling in open pans, and all kinds of applications for regulating the heat to an even temperature were adopted. In 1813 the honourable Charles Edward Howard adopted the well-known principle that fluids will boil at a much lower temperature in a partial vacuum than in an open vessel. He invented a close copper vessel, the middle of which was cylindrical and the top and bottom spherical in form. The bottom of the pan was double, the cavity between the inner and outer bottom forming a cavity for steam, the admission of which raised the contents of the pan to any required temperature, while a coil of copper pipe also carried steam through the body of the pan and assisted the evaporation of the syrup. The bottom cavity contained steam at low pressure, the spiral coil was supplied with steam at high pressure, and consequently at great heat. From the centre of the dome of the pan a bent tube and apparatus was connected with an air-pump, so that the pan could be almost entirely exhausted of air, while a valve would admit air in case the pump should exhaust the pan too rapidly.

The air-pump being at work during the process of evaporation, the sugar could be boiled at a temperature of 130 to 150 degrees, while the exact heat could at any moment be ascertained by properly adjusted thermometers.

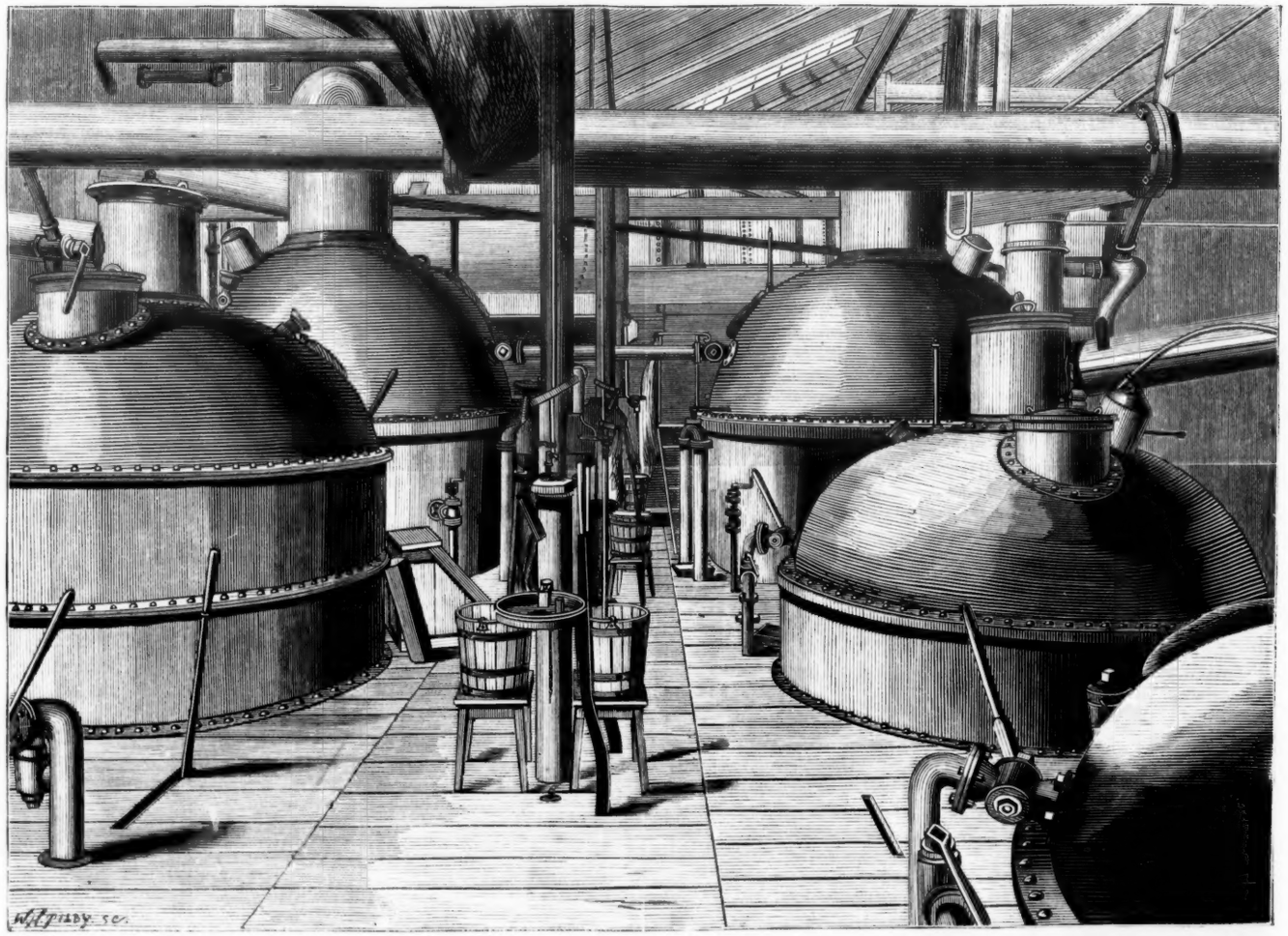
Howard's vacuum pans appear to have been the models for all later improvements, and these vast evaporators at Messrs. Finzel's are constructed on the same kind of principle, but with additions and fresh applications which not only reduce the boiling point to the lowest number of degrees of heat, but give admirable facilities for testing the crystallized condition of the sugar, which is to be seen through a round glass peep-hole in the side of the mighty pan, bubbling and moving into crystal forms which ultimately fall to the bottom of the evaporator, where they lie in a moist grainy mass, that is suffered to fall into one or other of the long row of copper coolers beneath.

It is after this operation that the process peculiar to Messrs. Finzel's manufacture commences, by the reception of the sugar in a kind of semi-cylindrical trough which travels along the "centrifugal" room, above the machines which it is intended to supply.

These centrifugal machines ot which there are a number constantly at work, are large copper cylinders fitted with an inner lining or jacket of wire gauze, between which and the outer pan some space is left. Each cylinder revolves with great velocity on a central axis, so that when charged the sugar which it contains is whirled swiftly enough to throw off the superfluous moisture, to complete its lustrous appearance, and to make it perfectly hard, dry, and concentrated.

So rapidly is this operation effected, the cylinders making many revolutions in a second, that a hundredweight and a half of sugar is completed in ninety seconds. From each cylinder a perambulator receives the sugar which is taken to another floor to cool, and then carried by means of a lift to the "mixing room."

This department of the manufactory is a vast hall, surrounded by a series of lofty stages or galleries, bound or edged with iron. It is to these stages that the sugar is taken when it leaves the centrifugal machines, and is received in the perambulators. These are wheeled to the edges of the galleries by the men in attendance, and thence by a simple contrivance canted up, and emptied of their contents into the space below which may be compared to an enormous bin full of shining crystals. The ap-



PANS WHICH WILL BOIL DAILY ABOUT 400 TONS

pearance of this entire department is very striking, the men in their white dresses standing to receive the various loads of sugar from above, and mixing them by means of wooden shovels.

It must of course be remembered that the crystallization differs in its various stages, so that the vacuum pans turn out crystals of various sizes during the process of evaporating. These have to be mixed in order to secure a certain uniformity of quality, and this operation is performed in the room to which we have now been admitted.

When once the mixing is effected the sugar is ready for delivery. In the floor of the mixing-room a number of trap-doors open to "shoots," under which are placed the tierces, bags, and packages, requiring to be loaded in the filling-room beneath. Each filler in this lower room has his particular trap or shoot, and when he requires a fresh supply of sugar a sharp peal on a bell makes known to the mixers that they must open the trap with another discharge.

The filling-room presents a busy scene enough, for not only are a number of men engaged in hooping-up and heading-in casks and tierces, but the sugar has to be pressed and rammed down by means of immense iron pestles, and the rapidity with which the various packages are sent out is at first almost bewildering. It is worthy of note, that each tierce and hogshead is entirely lined with a peculiar kind of waterproof paper which excludes both dust and moisture. Smaller parcels of sugar are made up in bags of the same material.

The supply of the tierces and casks is a large business in itself, and is the work of a branch-establishment two or three streets off, known as St. Paul's Cooperage, and under the direction of Mr. William Finzel, the youngest son of the principal partner. Here above 2,000 tierces are made every week, beside other packages, and 150 men are constantly at work. There is sufficient evidence of the extent of the operations at the refinery in this supplementary factory where more than 100 coopers are hammering like one, in the big shed, as we have to make our way from yard to yard amidst stores of rushes, hoops, and old rope for caulking heads and staves. There is a pervading atmosphere of beech, ash, and oak, the great stacks of which, either as staves or logs, which have to be reduced by a powerful circular saw, supply the 45,000 feet of timber which is the average weekly consumption.

As there are a number of raw sugar hogsheads and packages received here after they are emptied of their contents at the factory, a considerable economical process is established. Each cask or box is steamed out, the strips of buffalo hide, which have supplied the place of nails in the boxes are reserved for the glue makers, and several men are employed at straightening the nails for future use. A smart hand with a knack can earn as much as £3 a week at this work, while a novice may only be able to make twelve or fourteen shillings.

We cannot dismiss this subject without a word or two on the industrial and social relations established between Messrs. Finzel and their workpeople, and it is not too much to say, that those relations are distinguished by liberality on the one hand, and by appreciation on the other.

It seems to have been the earnest desire of the founder of the firm, who is still known as "the good Conrad Finzel," to establish a kind of family of workpeople, united by some other ties than those of mere supply and demand. His son, the present head of the business, and his grandsons, the present junior partners, have kept with faithful recognition to this intention: and the result is, that within the great building at the Counterslip there is a social organization very pleasant to contemplate. A higher rate of wages is paid than at any other refinery in the West of England, the object being to secure competent workmen, and arrangements of a very admirable kind are made for various contingencies. Not only is there a good benefit club, to which the firm is always willing to give its help, but there are a number of beneficial observances which are a part of the established practice.

Should the refinery stop working, wages go on at the same rate as usual, and any man meeting with an accident by which he is disabled, receives half his wages if he has been more than seven years in the employ of the firm, and seven shillings a week if his services have been less than that period. If the accident is fatal, and the man leaves a widow, she receives five shillings a week for life. A large number of the old workmen are also superannuated on a pension for life.

A library and reading-room are provided for the men, and in a house opposite the factory an excellent *table d'hôte* is provided for the employés of the counting-house department, while religious services conducted by a regular minister for the workpeople and their families, are held once a fortnight in a large room adapted for the purpose, though of course no one is expected to attend unless he desires to do so.

It would be difficult to find a more complete organization than exists at this Counterslip refinery, and as we return from our tour of inspection to the handsome counting-houses, where the walls are decorated with some curious old prints of Bristol, and with a highly enlarged engraving of the terrible "Acarus Sacchari," —which should be the horror of all consumers of raw sugar; we cannot help thinking for the thousandth time how vast small things become by aggregation. To supply the morning and evening "sweetener" of Messrs. Finzel's customers, above 700 hands are employed, and about 1,200 tons of sugar are turned out from this great building every week, of such perfect purity that the last analysis of crystals gives

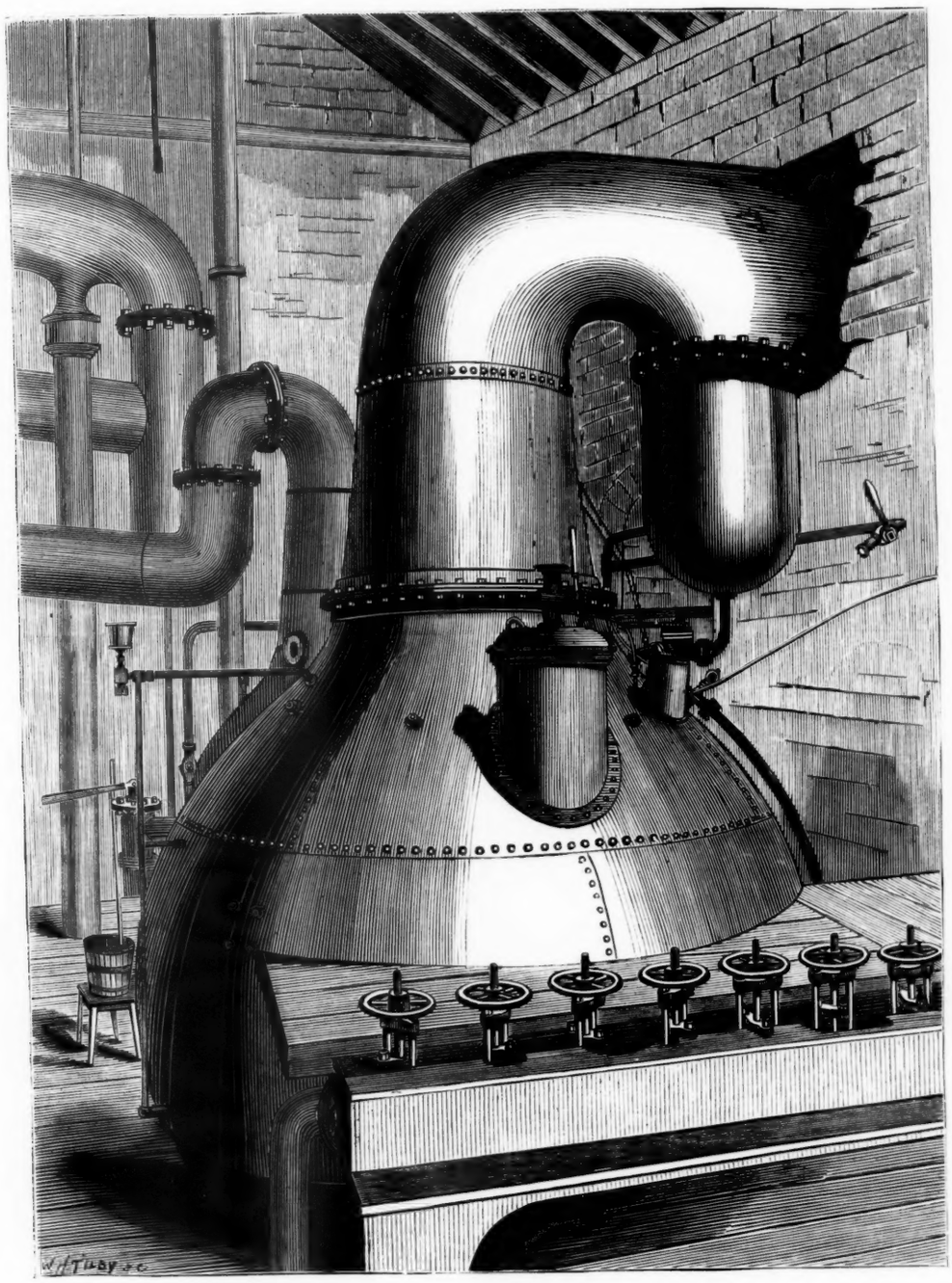
Pure cane sugar		99·923
Fixed ash	·018	·077
Moisture	·059	
		100·000

So that the total foreign matter (by far the larger part of which is moisture), is only $\frac{1}{1300}$th part of the gross weight of the sugar, —a degree of purity which cannot well be exceeded, even by the nicest chemical operations.

Indeed, as we last look round we are invited to the laboratory adjoining the private room of Mr. Finzel, and there see that not only is every kind of raw sugar tested with the utmost accuracy, but that the entire processes of the factory are gone through in miniature, under the personal superintendence of a professional chemist, who can perfectly conduct the operations of refining as much as 10 cwt. of sugar, with model apparatus which is precisely like that used in the works, but on a smaller scale.

VELOCIPEDES—THEIR FLUCTUATIONS IN PUBLIC FAVOUR.

THE display of bicycles, small but interesting, at the London International Exhibition in the present year reminds us of a fact which from time to time presses itself on our notice:—that particular classes of mechanical inventions, like special groups of mental studies and of social theories, have their periods of growth and decay, flood and ebb, maxima and minima. There is something in the human constitution which leads to this, generally if not necessarily; and all these waves of progress—discouragement alternating with hopefulness—deserve attention, because they tend in some degree to show the existence of a law of human work. The periodical appearance of a particular mechanical taste among artizans and inventors is indisputable—moving in one special groove for a time, then slackening speed by degrees, and finally getting out of the groove altogether. *Perpetual motion* had a long career of this kind; but it has been pretty nearly extinguished by a gradual acceptance of the scientific proof that the object in view is impossible of attainment. *Flying machines* have also had a long period of favour; and this favour, after many ups and downs, still continues, because really scientific men admit that some kind of mechanical imitation of flying is within the possible reach of dynamics. *Velocipedes* present a third example. Any one who has traced the progress of mechanical inventions during a series of years obtains abundant evidence that the taste for these contrivances has had many epochs of growth and decay, decline and revival. Men are impressed with a belief that manumotive or pedomotive machines, worked by the hands or by the feet, would be a useful substitute for walking on the one hand and for riding on the other; lessening the fatigue of the wayfarer on foot, and avoiding the expense of horse-flesh, fodder, harness, and stabling. The inventions arising out of this belief may develope into something permanently advantageous by and bye, and therefore the phases of their history are worthy of examination. Inventors are often fond of fine names for their inventions. The vehicles or contrivances which we have now under notice were some years ago known by the humble names of *hobby*, *hobby-horse*, and *dandy-horse;* but much more favour has been shown to the high sounding names of *velocipede*, *velocc*, *velocimane*, *pedomoter*, *manumoter*, *bicipede*, *tricipede*, *millipede*, *perambulator*, *célérifère*, *œllopode*, *monocycle*, *bicycle*, *tricycle*, and such compound designations as *velocipede horse*, *skater's velocipede*, *ice-velocipede*, *floating velocipede*, and *boat velocipede*. The Americans, too, have invented the name *velocimasiums* for riding-schools in which equitation with these wooden and iron horses is taught. If we wonder that clever men should ever think of these things, we may as well call to mind a passage in the "Life of Faraday." He and his brother-in-law, in moments of good-humoured idleness, sometimes "rode round the theatre of the Royal Institution on a velocipede; and tradition remains that in



VACUUM-PAN AT MESSRS. FINZEL'S WORKS.

(Will boil about 300 Tons a week.)

the earliest part of a summer morning, Faraday has been seen going up Hampstead Hill on his velocipede." One of our greatest philosophers thus engaged must have been a sight to see.

The Hobby-Horse or Dandy-Horse.

An undoubted elder brother of the hobby-horse was the *célérifère*, exhibited at Paris so far back as 1808. It was mounted on two low wheels; the rider sat astride on a bar above them; and the diameter of the wheels was such as to permit his feet to touch the ground. He strode on, something like a man walking very fast, and propelled his vehicle in so doing. Only a part of the foot-sole touched the ground at each step; and as the swing of the legs was considerable, it was possible to attain a considerable velocity. But the position and movements were awkward and inelegant; and the gay folk of Paris, in the Luxembourg Gardens, laughed at the exhibition. This was enough to disconcert the inventor; and the célérifère soon disappeared from public gaze. There was a German, one Baron Dreuze, at work on the same project; indeed, we are not quite certain but that he preceded the inventor of the célérifère. He claimed for his wooden horse these three good qualities—that it would travel up hill on a good road at a walking pace; that it would travel on a level road as fast as a trotting horse, and a very fast trot if the road were dry; and that it would travel down hill as fast as a horse can gallop.

A lull took place; the excitement of the earlier years of the century cooled down; and the hobby-horse went out of favour. Again in 1817, however, the fever broke out afresh, and for three or four years was very hot indeed. "Our present velocipedestrians," a journalist wrote some years afterwards, "have but little notion of the wonderful amount of ingenuity bestowed upon it by inventors—some of them carriage-builders, but mostly handy working-men who had a taste for cranks and wheels and levers. In the simplest original form the horizontal bar was nearly straight; a pad was placed on it near the middle, as an apology for a saddle; one wheel was under the first end, one under the rear end; the front wheel was pivoted, and guided by a lever the handle of which was managed by the rider. Bestriding the bar, with his two feet just touching the ground, he made very comical steps or starts forward, and compelled his horse to go with him because he was sitting on it. The curve which the foot of the rider described in each complete stride was a peculiar one, the mathematics of which would perchance have puzzled him to solve. Many varieties of form were tried to determine whether the bar should be nearly straight or follow a serpentine up-and-down curve; whether the two wheels should be equal or unequal in diameter; whether the saddle pad should be midway between them or nearer to one than the other; whether the pad should be on the bar or on a spring above the bar; and whether the lever for steering the front wheel should be nearly vertical or much inclined. Sometimes a triumph of genius was produced with two pads on a long pole, one behind the other, offering facilities for two men to bestride one steed."

The caricaturists made merciless fun out of these hobby-horses, or, as they were sometimes called, dandy-horses. A dictionary of quaint phrases and out-of-the-way terms, published about that time, gives as a definition of dandy-horse:—"Velocipede, or instrument for journeying far and fast; two wheels, one behind the other, supporting a bar of wood; the traveller gets across, and propels himself forward by striking his feet against the ground. Hundreds of such might be seen in a day; the rage ceased in about three years, and the word is becoming obsolete." There is a print extant, dated 1819, giving a view of Johnson's Pedestrian Hobby-Horse Riding School in Brewer Street, Golden Square, with printed instructions for riding. In a rare print by J. R. Cruikshank, published about the same time, entitled "Every Man on his Perch, or going to Hobby-Fair," there are represented twenty-four riders on velocipedes or hobby-horses; the men so dressed as to indicate their trades or professions, and their wooden horses so shaped as to symbolize the same thing. A sailor sits in a boat-velocipede; a fiddler on a violin-velocipede; a soldier on a cannon-velocipede; a tallow-chandler on a candle-velocipede; an apothecary on a labelled phial-velocipede; and so on. Most of these are of the bicycle kind, with the feet of the rider on the ground and a handle to guide the front wheel. The more celebrated George Cruikshank illustrated a satirical "Dandy Book," published by Hone, in which, among other figures, a dandy is represented painfully struggling up hill on his hobby-horse, while another dandy is riding down hill and threatening to overwhelm him. One satirist discoursed of

> "Patent pedestrian accellerators,
> Floating velocipedes, perambulators,
> Or hobbies, at present which so much the rage are,
> That asses they'll banish from Brighton, I wager."

The Revival of Velocipedestrianism.

We cannot fix the date very precisely, but it was in or about the year 1866 that another wave of public favour was enjoyed by this new kind of locomotion; the flood tide rolled in swiftly until about 1870 or 1871, and during this period a kind of velocimania held the public—especially the public of Paris. France unquestionably took the lead of England in the matter, if not of the United States also; and it is impossible to glance at the French journals, particularly those of 1868 and 1869, without being struck with the amusing display of enthusiasm on the subject. Velocipede races were held in the neighbourhood of Paris, at St. Cloud, Vincennes, Enghien, Pantin, and the Bois de Boulogne; riders dashed along the Champs Elysées and the boulevards. We shall presently have to speak more definitely of the difference between bicycles and tricycles—two-wheel and three-wheel velocipedes; but it may here be stated that both came into favour at the time we are speaking of. Velocipedists of superior gymnastic skill would rise up in their seats, lie down on their backs, let go the handle of the vehicle, and throw both legs over it. Government clerks, living in the suburbs of Paris, often rode to office in the morning on their velocipedes, returning at night with swinging lanterns to light them home. 'Pushing' tradesmen sent out illuminated velocipedes in the evening, with advertising transparencies. Compositors engaged on the morning newspapers journeyed to and fro on their wooden horses. Collecting clerks engaged at the banks similarly made their rounds. In the provincial districts, seaside tourists took their velocipede rides along the coast and beach at the watering places; sportsmen sometimes chased their game on a similar mount; artists employed them on sketching tours; photographers moved about from place to place with their camera and knick-knacks strapped to a three-wheeled horse; velocipede races were as fashionable at country mansions and parks as croquet parties have since been; electors on one occasion rushed to the poll on velocipedes, when an opposing candidate had hired all the available vehicles and horses of ordinary kind; while velocipedes were made to take part in many spectacular dramas on the stage. Red-hot enthusiasts urged the Government to introduce velocipedes in all sorts of novel ways—for the assistance of rural postmen and telegram messengers; for infantry regiments, to enable outlying pickets to reconnoitre the enemy, and to communicate speedily with the main body of the army; for the formation of a species of light cavalry; for the mustering of life-boat crews on thinly-inhabited coasts; and for the rural police, or *gardes champêtres*, in taking their daily and nightly rounds. Although these sensational suggestions were not adopted, velocipede schools were established, with professors of the new art of equitation; and the newspapers described in glowing terms the velocipede made for the Prince Imperial, with its rosewood and aluminium adornments.

Velocipede clubs became one of the incidents of the movement. They were of two kinds. Some resembled the humble coal-clubs, goose-clubs, clothing-clubs, &c., much in favour with the working classes; in which weekly payments are made for the eventual purchase of the articles connected with the name and origin of the club. But the principal clubs were of a higher order. The members were gentlemen who had the means and the leisure to indulge in the new kind of locomotion, liberal in the finish and decking out of their velocipedes, and willing to devote day after day to races and journeys of considerable magnitude. These clubs, like most others, have flourished more in England than in France; the same genial, social groundwork was found for them as for cricket clubs, croquet clubs, archery clubs, golf clubs, polo clubs, rowing clubs, yacht clubs, four-in-hand clubs, gun clubs, &c.

The Americans, while taking their full share in the invention of bicycles and tricycles, have contributed also to that merry kind of banter for which their humourists are so distinguished. A few years ago a challenge was put forth to produce a good rhyme to "velocipede," acknowledged to be rather a tough combination of syllables to deal with. One response to the challenge assumed the following form:

> "There was a man on a velocipede,
> Who said, I need not give my hoss a feed;
> Without oats or hay
> He will go all day;
> It's a cheap thing to keep a velocipede."

While another solved the difficulty thus:

> "If 'tis a loss, indeed,
> To give one's hoss a feed,
> And I can boss a steed
> Of such a saucy breed;
> Then sure the hoss I need
> Is the velocipede."

It would not be easy, we imagine, to exceed this number of queer rhymes to the word in one stanza. The dry humourist who is known in America as Josh Billings thus discourses concerning velocipedes :—"It don't take much stuff to build a filosipede. I am bold tew say that a man could make one ov' 'em out of a single plank, and then hev enough stuff left over to splinter broken limbs, or make, perhaps, a corfin. A filosipede can't stand alone; and that single fact is enuff to condemn the thing in mi eye. I don't want to hev anything to do with any hopeless critter that can't stand alone—unless, I might add, it is a purty woman going for to faint. I don't think it will ever git intew gineral use among farmers, az it has no convenience for a hay-riggin, nor even a place to strap a trunk; and az tew going tew church on it, the family would hev to go one at a time, and the rest walk. So, of course, the thing is killed in that direction."

The Bicycle.

We have purposely let the above gossip take its own course, because the revival of this kind of locomotion, seven years ago or so, applied both to the two-wheeled and the three-wheeled machines; but we must now describe the contrivances a little more in detail. There is really considerable mechanical ingenuity in many of them deserving of notice, even if the system itself should not become permanently established. A history of failures, in this as in other matters, forms part of the history of progress.

The *bicycle* of the present day differs from the *hobby-horse* of the last generation mainly in this—that while both are two-wheeled vehicles propelled by the feet of the rider, the hobby-horseman touched the ground with his feet at every step, whereas the bicyclist keeps his feet at a considerable height above the ground. In most bicycles the two wheels are one behind the other; the rider sits on some kind of bar or wooden saddle over them (or over one of them, or over the space between them); his feet rest on two pedals or treadles; these pedals are connected with cranks; and when the feet work or press alternately, these cranks cause the wheels to revolve and the vehicle to progress. This is perhaps the simplest definition of a bicycle; but the variations in mechanism and action are almost infinite. Two wheels of equal size; the front wheel larger than the other; the hind wheel larger than the front; the rider sitting near the front or nearer to the back; his feet pressing rather downward than forward, or forward rather than downward—each of these is the type of numerous varieties. How long this construction has been known is uncertain; but it can unquestionably be traced back more than thirty years. Those now made are principally of wrought-iron, light and strong; the pedals are connected by cranks with the front wheel, and there is generally some kind of brake provided to stop the vehicle when necessary. This brake mostly acts on the hind wheel, and is governed by the rider through the medium of handles.

The variations in the bicycle are indeed so numerous, that a description of them all would be well-nigh impossible, even if any useful purpose would be fulfilled in writing it. Not a bar, wheel, axle, crank, lever, pedal, but has undergone various changes. In some, as we have said, the feet press rather downwards than forwards, and a controversy has arisen between the advocates of the two arrangements. In some, the wheels are provided with double spokes, to impart strength. One maker has attempted to enable the rider to vary the length of the crank at pleasure; a short crank is best for fast travelling, a longer crank for mounting an incline; and it is admitted that the muscular powers of the rider would be economized if he could accommodate his bicycle to these varying contingencies. There can indeed be no question that the science of human bones and muscles, tendons and ligaments, is intimately concerned in this subject.

Concerning the speed of bicycles, there is no scantiness of evidence that it is sometimes considerable, and can be maintained for a considerable time. Two Frenchmen challenged each other to accomplish the longest distance in twenty-four hours; one achieved eighty-seven miles and then broke down; the other ran up his score to a hundred and twenty-three miles. A party of nine Rouen gentlemen rode their bicycles from that city to Paris and back, a distance of eighty-five miles, between an early breakfast and a seven o'clock dinner. Three bicyclists went from London to Brighton at the average rate of eight miles an hour, the maximum speed being nearly double this amount. A bicycle race was run near London, limited to four miles; there were five competitors, one of whom did the distance in seventeen minutes twenty-one seconds, while another went over two miles of the course in six minutes five seconds. A bicycle called the Aerial Lever, with a front wheel forty inches diameter and a hind wheel twenty-four, ran eighteen miles in one hour and twenty-seven minutes. Two riders on a four-wheel vertical tread velocipede ran eighty-four miles in one day. A famous bit of one mile running was accomplished in two minutes and a-quarter. Two members of the Liverpool Velocipede Club went from Chester to London in three days, viz., Chester to Wolverhampton on the first day, thence to Woodstock on the second, and finally to London on the third. A bicyclist ran from Abergavenny to Cheltenham, fifty-four miles, in six hours and a-half. An expert bicyclist, in the service of one of the makers, accomplished the tough achievement of a journey from London to Edinburgh, about four hundred miles, between Friday morning and Wednesday evening; his Sunday travel was purposely made small in quantity, and thus the time was practically far within six days. A rider on one of the Aerial bicycles accomplished a run from Coventry to Lewisham, over a hundred miles, in one day. Another rider, taking matters a little more easily, sped over forty miles before dinner, and then another forty after dinner. A youth of sixteen years of age (if we may believe the recorded accounts) started from Ryburgh station, in Norfolk, one morning at half-past four, on a thirty-six inch wheel "Ariel" or "Aerial" bicycle, travelled through Newmarket and Whittlesford, and arrived at Ware in Hertfordshire at half-past four in the afternoon, doing this long distance just within twelve hours. The newspapers recorded, during the spring of the present year, the particulars of a bicycle tour made by a party of gentlemen round the south-eastern coast, dispensing alike with the services of horse-flesh and of the circular tour tickets of the railway companies. These bicyclists started from London and wended their way through the northern part of Kent to Canterbury, thence east to Margate and Ramsgate, and west to Sandwich and Deal; pulling up and dipping down into Dover, and so on through Folkestone and Hythe to the Romney Marsh region; then taking Winchelsea and Rye on the way to Hastings; next through Eastbourne to Brighton, and finally back to London. A few mishaps took place on the road, such as tumbles and breakages, but the travellers pretty steadily accomplished their sixty to seventy miles per day, giving a rest to their iron steeds, as well as to themselves, in some comfortable hostelry at night. Whether it has ever been exceeded on the Continent we do not know, but the longest bicycle journey ever made in this country was from London to John o'Groat's, at the topmost verge of Scotland, up-hill and down dale, for seven or eight hundred miles. The most recent example, and not the least interesting, took place the other day between members of the Middlesex and Surrey Velocipede Clubs. Out of twelve competitors four accomplished the entire distance from London to Brighton and back within twelve hours; one of them within the surprisingly short space of eleven hours and ten minutes—nine miles an hour from first to last.

The Tricycle.

The swift races and long journeys just noticed have nearly all been made on bicycles; for it is observable that velocipedists who belong to clubs and engage in contests hold in something like scorn vehicles with three or four wheels; the bicycle is more difficult to manage, and is therefore regarded in a more scientific light. Nevertheless, the *tricycle*, being safer, and permitting the gentler half of creation (or the gentler half of French creation at any rate) to participate in these curious modes of locomotion, has its advocates. One wheel—usually in front—has the pedals used in propulsion, and it also acts as a guiding wheel through the medium of handles. The hind wheels, parallel on one axle, or on two axles in a right line, are either larger or smaller than the front, according to the mode of construction. The place for the rider varies from a mere bit of covered wood as a saddle to a well-cushioned and handsomely fitted seat (the latter especially if the vehicle is for a lady). The pedals are often shaped something like Turkish slippers, into and out of which the feet of the rider may be moved readily. Some tricycles have a side lever so attached to the wheels that the rider, by applying one hand to it, can augment the speed produced by the action of his two feet, or by another action can make it act as a brake. The movement of the feet is not very unlike that of walking, an alternate lifting upwards and thrusting forward; and if the diameter of the front wheel is judiciously chosen in relation to the stature of the rider (or rather to the length of his leg), a ride of many hours' duration may be borne without much fatigue. The foot does not really *press*, and expend muscular power in so doing; it has a slight circular movement confined within a few inches of distance.

As there are more wheels and axles, cranks and levers, in a tricycle than a bicycle, there have been (as might reasonably be expected) a greater number of mechanical inventions relating to the former. If the Patent Office were rummaged, we should find a formidable list of patented tricycles; while the periodical literature of the last sixty or seventy years provides the means of considerably augmenting the catalogue. Merryweather's pedomotive carriage consisted of a strong, light frame mounted on a pair of large wheels, with a smaller guide-wheel in front; three pedals were connected with a three-throw crank; two persons

sat side by side on a seat over springs, and a third on a seat over the crank; the two hind-sitters propelled the vehicle by means of the three pedals, one pedal being common to both of them; the fore sitters guided or steered. A tricycle brought out about thirty years ago had a pair of large wheels in front and a small one behind; stirrups or pedals were attached to a crank connected with the axle of the front wheel, while the hind wheel moved on a pivot like a garden chair. Dr. Cartwright, the inventor of the power-loom, devised a tricycle which was at once pedomotive and manumotive; the axle of the driving wheel had two pedals, worked by the feet of the rider, and the hands were made to contribute also to the motion. "I know a country postman," said a correspondent of a weekly journal a few years ago, "who has a tricycle. He runs out of town in the morning to several villages, delivers his letters, and goes back again, does half a day's work at carpentering, and rides out again for the letters for dispatch in the evening. His wife often goes out with him for a ride on Sundays; and he will take up a passenger on his way home. This man has done his forty-four miles in four hours and twenty minutes." This cosy vehicle was, of course, double-seated. A contrivance called the "triangular velocipede" had the three wheels more nearly equal in size and arrangement than is usually the case in tricycles. A "fly-wheel velocipede" has been constructed for two persons sitting side by side. The "trotting velocipede" has such an arrangement of springs and cranks, that the rider propels it by a kind of trotting up-and-down movement of his body. The "Macclesfield velocipede" has two dished wheels in front, twenty-four inches diameter, and a much larger plain wheel behind; and these wheels are worked by a manumotive instead of a pedomotive action. There is a French "windmill velocipede," which has a small windmill or vane in front to aid the propulsion; but we doubt whether this queer conceit has ever been practically tried. A "balloon velocipede" belongs to the same fanciful class. The "velocimane," introduced in Switzerland, has two very large wheels, and one smaller; it is worked by the hands of two persons, one before and one behind, by means of handles, and will accommodate three persons besides the driver; the feet are not used as means of propulsion. One form of tricycle has two front wheels five feet diameter, worked by two riders, whose hands manage two cranks on the axle of the wheels. The "sociable velocipede" is a tricycle with two seats for two persons each. The "ice velocipede," or skating horse, is not so much a tricycle as a monocycle with two skates instead of hind wheels; the one wheel has sharp points at its periphery, to enable it to bite the ice sufficiently; two bars connected with the axle of the wheel descend to the ground in the rear, and are shod at the ends with steel skates or runners—an arrangement which enables an expert rider to attain great speed. The "steam tricycle" is really a road locomotive, and therefore does not belong to our present subject. The "rowing velocipede" has levers and cranks so adjusted that the manumotive power of two riders can be exercised by a kind of rowing action, which some authorities consider to be one of the most effective for the muscles.

Specialities in Velocipedes.

Apart from the generally recognized bicycles and tricycles of the velocipedic world, manumotive and pedomotive, various other forms have from time to time been brought under public notice—some actually tried, with more or less success; some patented, but never tried; some drawn on paper but never patented, and others merely suggested, without being either sketched on paper or constructed in wood and metal. Let us jot down a few of these, more frequently oddities than not.

Nearly a hundred years ago, M. Blanchard, the celebrated aeronaut, aided by M. Masurier, a skilful machinist, introduced to the Parisians a vehicle which was driven in the Place Louis XV., and was watched by many members of the French Academy of Sciences. From the extant descriptions of it, this machine seems to have presented the figure of an eagle with outstretched wings, to which some kind of driving apparatus was attached. Two men were seated, the one in front to guide the machine, the other behind to propel it; this propulsion was effected by the alternate action of the two feet, the driver's legs being half concealed within a box which contained levers and springs. The published description did not clearly show whether the feet pressed alternately on the ground or on the levers, but he was able to sit or stand at discretion. The vehicle or machine was then exhibited before Louis XVI. and Marie Antoinette, after which it fell into obscurity. Just half a century ago, one Mr. Dumball described an astonishing velocipede which he had invented, a vehicle with feet instead of wheels. "I accommodate the feet I use," he explained, "according to the ground I have to go over; the cloven feet being wisely adapted by nature to some soils, the web feet to other situations, the horse's hoof to others. A boy, rolling like a wheel along the roads, and using his hands and feet as the spokes of a wheel, is descriptive of my method; so also is the Manx penny, with the legs of a man upon it; and likewise the spokes in a coach wheel without felloes, or projecting beyond the felloes; or a given number of these spokes projecting through the felloes, which spokes may be made more fit to pass over the highways, &c. if shod with iron or other hard body. Or these shoes I attach to the felloe of a coach-wheel, with springs acting at the heel and toe, in order that the shoes may move on a pivot or hinge, resembling the motion of a man's foot. . . . . When required, I make the spokes or legs with joints, resembling the thigh, knee, and foot of man." The same patentee's hobby-horse on crutches must have been a sight indeed! "I apply stilts, crutches, and the tread-wheel in moving vehicles where the labour of men can be substituted for horses. A man on stilts being able to make longer strides than without them, can consequently move over a greater space in the same distance of time. In this case I provide a seat for a man to rest on, like the seat of a rocking-horse; and crutches I apply like unto the method of punting vessels." One Mr. Jameson invented a velocipede like a Bath chair, with a long riding pole attached. Another had one which moved by means of a large screw attached to a cogwheel, which in its turn acted on a train of wheels; there were two running wheels, one behind the other, and four iron rods on each side, with a small roller at the bottom of each; the rider propelled this complex apparatus by turning a handle. Forty years ago a new product of ingenuity came upon the public quite as a surprise. It was a vehicle with a circular ring wide enough to encompass a rider or driver round the waist; from the sides of this ring projected two horizontal shafts, to which were fixed a pair of light wheels six feet in diameter; the arms of the driver were supported on two short crutches fixed upright on the ring; and the man was thus so held up that his feet could just touch the ground. The rider strode along, and made the wheels roll with him while his hands governed a lever for guiding, stopping, and turning. His actual movement was a sort of running, with which he could attain a speed of nine miles an hour. A sailor one day made his appearance in the city of York on or in such a vehicle, much to the amusement of the citizens. The late Mr. Baddeley, a man of considerable mechanical ingenuity, invented a velocipede in which, like the machine just described, the rider was between two large parallel wheels; but the feet, instead of touching the ground, pressed two pedals which governed a small guide-wheel in front; while the hands propelled the machine by means of an axle with cranks. About the same time a contrivance submitted itself for public favour in which a tricycle and stilts were combined in a very odd way. Two wheels, about six feet diameter, were placed parallel, about a yard apart; the rider sat on a balanced seat between the wheels; to the bottom of his feet were attached stilts about two feet long; and (so far as the description is clear) the rider propelled the vehicle by pressing the stilts alternately on the ground. Some inventors have sought to adapt the multiplying wheel to a velocipede, by having a train of cog wheels working one into another, so as to multiply the speed sixfold; but the theorists forgot that the rider would have to exert sixfold the force which would be necessary for ordinary speed. One constructor has planned to make his bicycle fold or shut up when not in use; another to steer it by cords instead of levers; a third to lessen shocks and jars by the intervention of india-rubber springs; a fourth to enable a bicyclist to mount and dismount without capsizing; a fifth to enable two persons to sit face to face in a four-wheel vehicle, both to help in propelling it, and contriving that it shall steer in either direction. A one-legged man desiring the comfort of a velocipede, ingenious constructors managed somehow to gratify this puzzling want. A novel bicycle had two very large wheels, parallel, with seats for two persons between them; and those two persons propelled the vehicle by working one winch handle. Strange as it may seem, a *monocycle* has been devised; it consists of a single wheel, six feet diameter; a driver, sitting in the wheel, propels it with his feet, and keeps his balance by the aid of an arrangement like that of the sun-and-planet wheel.

Floating velocipedes are to be numbered among the forms adopted. Lucas's contrivance for this purpose has two propelling wheels and a rudder, each in water-tight compartments; the feet of the rider turn the shaft of the wheels and propel the machine, the paddles of the wheels dipping a little way into the water, and the rider being perched on a framework above. The "Boston water velocipede," so called, has one wheel in a boat, the wheel dipping down into the water through an opening in the bottom of the boat; the feet of the rider act on pedals connected with the axles of the wheel; the rudder is worked by lines governed by

his hands. An officer of the Madras army has devised a water velocipede consisting of two canoes, with a platform stretching across from the one to the other; they are ten feet long by one foot broad, and the space between them is three feet wide; two paddle-wheels, each three feet diameter, dip down into the water through this space; the rider, on a seat above the platform, works the paddle-wheels with his feet, through the medium of rods and an oscillating bar acting on the cranks; the canoes will accommodate two additional persons each, whose services are not needed to propel the craft.

Velocipedes at the Exhibition.

The velocipedes at the International Exhibition remind us that there was something of the kind four years ago at the Crystal Palace; it was called the "International Velocipede and Locomotive Machine Exhibition;" but the foreign element was nearly absent. So it is in the present instance; and therefore the display, so far as concerns these mechanical substitutes for horses, is English and not international. The vehicles are characterized by high finish, especially those in polished iron and steel; but there are no great novelties of construction. The lead is taken by the large-wheel bicycles—some with a 53-inch front wheel. Messrs. Smith and Starley send "Ariel" bicycles, which, provided with their patent rudder, lever tension wheels, india-rubber tires, registered cliptail sliding spring, steel-bushed adjustable cranks, rubber-clothed pedals, roller brake, leg-guard, and pig-skin saddle, are claimed by the inventors to be "the lightest, strongest, safest, easiest, cheapest, best finished, and most elegant of modern velocipedes." The price ranges from £10 to £31 10s. Mr. Harris sends a four-wheel velocipede, Mr. Keen a travelling bicycle and a racing bicycle,—the racer, as in real horseflesh, being of slighter build than the road-hack.

In these, as in most other matters, the eventual success of mechanical inventions depends greatly on the manner in which the public are invited to regard them. Velocipedes are either for amusement or for use; if for both, the indefiniteness of the purpose will probably defeat itself. If for amusement, they will be likely to have their day of fashion, and then pass temporarily into decline, like many out-door games and pastimes. It is as articles of use that we would regard them, in reference to permanent adoption and general diffusion. The velocipedists, makers and teachers, should show that there are some situations in life, some exigences of travelling, in which the wooden or iron horse is better than any other media of locomotion. Those other media are railways, tramways, steam locomotives on common roads, omnibusses, cabs, other road vehicles, and saddle-horses. (To be blown through great tubes, or to be wafted overhead in balloons, are matters for which we are not yet quite ripe, considered in relation to daily and hourly travel.) Let the advocates of velocipedes make out a clear case of superiority, even for a few of the requirements of public travel, and they may be certain of establishing a somewhat important branch of manufacture.

STEAM AND WATER AS MOTIVE POWERS.[1]

HOMER in the "Odyssey" shows us twelve slave-girls occupied in the palace of Ulysses in tediously bruising between two stones the wheat essential for each day's consumption in the royal household. Under the tents of the Arab chiefs of the Algerian Sahara matters are managed now precisely as they were long ago at Ithaca. There is no mill, and there the sweat of ill-fated woman has yet to supply the want. One of these unfortunate creatures engaged in pounding grain cannot, with the severest labour, do more in a long day than furnish five-and-twenty mouths with the bread of which she herself tastes so little. Now, if we enter one of our Alsatian flour-mills, provided with every possible modern appliance, where the grinding, sieving, and sacking appear to go on of themselves, the well-paid, well-fed workman who watches and directs these different operations will tell us that he himself, and without much labour either, can in a single day produce first-class flour enough to feed four thousand men, or more. In these two cases, without a mill or with one, the difference in production is the proportion of 1 to 160, a proportion very inferior to that of much of the work accomplished, with or without machines, in the manufacture of our clothes. To-day, in the cotton-spinning factories where machinery is employed, one man can spin as much thread as five hundred men a century ago, and in the weaving factories he could do more in a single day than the weavers of Central Africa, with their rough implements, could effect in many months.

This difference of production between the labour of the spinner with the hand-spindle and the labour of the spinning-jenny, or between the modern corn-mill and the primitive grain-crushing stones, gives some idea of the advantages of machinery. Machinery augments production, while it simplifies, diversifies, and increases labour. From each invention, each perfection, springs up a new source of riches to mankind. All progress in machinery is for us an enfranchisement and a redemption; and it is only when we have fully reckoned up its influence that we really understand how its power is at once emancipating and benevolent—a benevolent power in the development of our well-being, in the entire satisfaction of our wants—an emancipating power in lightening the burdens of the necessities and the physical weaknesses that oppress all that intelligence, all that higher aspiration which, waiting for its time, is ever concealed somewhere in the impenetrable depths of the human soul.

The growth of labour with the multiplication of machinery is proved by the increase of motive powers. Thus the construction of the first steam-engine in Alsace dates from the year 1812. In 1838 there were already in the single department of the Haut-Rhin eighty-three steam-engines, with a nominal 1,778 horse-power, and erected in sixty-seven establishments, nearly all of them cotton-spinning factories. Of the total of 3,850 steam-engines, having 32,000 nominal horse-power, that Alsace owns at present, the Haut-Rhin absorbs 18,558 horse-power in 2,263 engines belonging to 501 establishments. Simultaneously with the numerical increase of steam-engines, their construction has been perfected, their motive power increased, their cost of maintenance diminished according to an equal proportion. The engines which before 1840 supported a double atmospheric pressure, are now constructed for a pressure three times as strong. The expenditure of fuel per one-horse-power per working hour, as high thirty years back as 4·5 kilogrammes for low-pressure engines, and 8·2 for high-pressure, is now not more than 2·5. In the same interval, however, say from 1840 to 1870, the annual consumption of coal in the Haut-Rhin has been raised from 38,000 to 400,000 tons, leaving the coal required for railway purposes altogether out of the question. During the last ten years the importation of coal has increased 58 per cent., while the nominal steam power has been doubled.

In reality the nominal power of steam-engines in this question represents only two-thirds of their effective power. In consequence of the custom of the engine-builders, or through the influence of fiscal considerations, the nominal steam-power declared to the administration always remains below the actual power. For instance, one cotton-spinning factory, with an engine of 140 nominal horse-power, requires and really obtains from this engine an effective power of 205 horse, determined by exact experiment with the dynamic test. In other establishments the gain is still greater, for we often see work requiring from 148 to 185 horse-power furnished by steam-engines of 70 or 80 nominal horse-power. According to a report of M. Keller, mining engineer, read before the Société Industrielle de Mulhouse, in lieu of the declared power of 2,273 horse in the cotton-spinning factories of that *arrondissement* for engines all driven by steam, a working power of 3,679 horse was required, if we calculate 115 spindles to one horse-power. Now, these 115 spindles, put in motion by one horse-power, represent an average, deduced from numerous experiments tried with the dynamic test on engines of various systems and in spinning mills, varying in importance from 10,000 to 30,000 spindles. With this average of 115 spindles we have the considerable increase from 95 to 225 spindles per horse-power; but this is an extreme noted in two cases only, and in eight establishments out of ten the gain does not oscillate above from 106 to 141 per horse-power. The nature of the machines and their state of repair, the number of preparatory machines, the fineness of the threads, the degree of twist, are each and all susceptible of modifying the number of finishing spindles driven by the same unit of power. In the same way for weaving, the number of the looms set in motion by one horse-power varies according to the nature of the texture, the size of the machines, and the frequency of the shuttle-strokes; this number is generally five, an average figure obtained by dividing the number of mechanical looms in all the weaving establishments of the Haut-Rhin by twice the nominal power of the steam-engines employed.

In the time of its origin in Alsace, the cotton industry was established in the interior of the valleys, so as to utilize the streams coming down from the Vosges as motive powers. As soon as the mills increased in number it was found, however, that the force derived from the variable mountain torrents, subjected as they are in summer to long periods of drought, was

[1] A lecture delivered before the "Société Industrielle de Mulhouse," by M. Charles Grad. (Translated from the "Revue Scientifique.")

far from regular or sufficient, and to avoid times of idleness, therefore, it was necessary to supplement this insufficient water-power by steam-power, and the new factories were built in the plains in the proximity of railways or navigable rivers. In the plains they endeavoured to compensate by economy of transport, for the prime advantage offered by the falling waters of the valleys. Owing to the influence of easier transit, the price of coal at Mulhouse fell one-half, at the same time that the improvements in the steam-engines themselves considerably reduced the required quantity. At Mulhouse, in 1838, Saint-Etienne coal, carried by rail or canal, brought from 36 to 40 francs per ton; Epinac coal, carried in either way, from 28 to 32; Blanzy coal, by canal only, from 25 to 33; Saarbruck coal, carted or by canal, from 37 to 41. On the canals the price of transport did not exceed 7 centimes per ton weight per kilometre, while cartage down to the depths of the valleys was as high as from 30 to 40 centimes, and even more, according to the state of the roads. The extension of the network of railways and of the canal system from 1859 to 1870 has reduced the price of Saarbruck and Ronchamp coal at Colmar from 28 to 22 francs per ton, while the consumption in the factories on the Haut-Rhin has increased from 211,593 to 367,000 tons.

Without any important coal-fields of its own, Alsace does not, however, find much difficulty in procuring fuel either from France or from the German provinces on the Rhine. Thanks to the development of the iron-way, which for the last ten years has steadily penetrated towards the region of the mountains, the cost of transport to the interior of the valleys is no longer opposed to the carriage of coal to the most distant and retired factories. Besides this, the late rise in the price of coal caused by a vastly extended demand in all branches of industry has restored their old superiority to the establishments provided with water-power. Whether the water-driven engines work alone during the whole year, or whether they are supplemented in times of drought by steam-power, the factories which are happily provided with them have a marked advantage over those which are wholly dependent on the use of steam, and their conditions of labour are much more favourable. A few calculations will aid us in establishing with sufficient detail the relative value of water and steam as engine-driving powers.

Two features should be considered in the industrial value of a motive power—the prime cost of establishment and the expense of maintenance. The expense of maintenance, insignificant for water-engines, is a very serious item in steam-engines. The prime cost of establishment, or the interest representing it, varies much between the two powers; the first cost of the fall of water may equal or even surpass that of the steam-engine. In a true spirit of economy, one should from preference employ water-power, either alone or combined with steam, wherever their use costs less than the exclusive use of steam under the same conditions. With a few rare exceptions, the great cotton factories, even at the bottom of the valleys, ought to establish auxiliary steam-engines, side by side with their water-mills, to avoid the droughts and to ensure regularity of labour. The steam-engines could then come in as assistants when the water-stream which ordinarily sets the machinery in motion has not the necessary power. The cost of one day's work for one horse-power in steam varies considerably in different establishments. The cost of labour with water-power depends chiefly upon the particular conditions of the original outlay, and increases or diminishes according to the power or the regularity of the waterfall. To ascertain the actual relative value in one district of water and of steam as motive powers, let us consider the expenditure on these powers when working together in a few manufactories, and compare their cost of labour with the cost of labour of steam-engines by themselves under the same conditions, supposing that these work alone and continuously.

Here, for example, are three establishments provided at the same time with water-mills and steam-engines, situated all three upon the same stream of water, the volume of which is the same for all, but the height of fall different. The water stream is the Canal de Logelbach, a branch of the Fecht, starting from that river at Turckheim as a water-way to Colmar. The establishments consist of one cotton spinning-mill with 14,000 spindles at Turckheim, with a fall of three and a-half metres; of another spinning-mill, with 56,000 spindles at Logelbach, having a fall of fifteen metres; and of a cotton-weaving factory, occupying some thousand looms, and having a fall of one metre and a-half, at Colmar. The volume of the canal is equal to 4,000 litres a second, and suffices in the times of high-water to set in motion all the machinery in the mill at Turckheim, which requires a force of 130 horse; while the mill at Logelbach, requiring a constant power of 480 horse, and the weaving factory at Colmar, requiring 200 horse, are compelled all the year round to employ, in concert with water-wheels, steam-engines of a power varying according to the greater or lesser quantity of water. The proprietor of the three factories, M. Antoine Herzog, taking careful notes day by day, has been able to fix month by month from 1st July, 1871, to 30th June, 1872, the exact days of one horse-power each that have been respectively furnished by the water and by the steam. Here are his figures:—

1871-1872.	Spinning-mills of Turckheim.		Spinning-mills of Logelbach.		Weaving Factory of Colmar.	
	Water.	Steam.	Water.	Steam.	Water.	Steam.
	Days.	Days.	Days.	Days.	Days.	Days.
July	1723	1657	7284	5196	728	4472
August	974	2406	4236	8144	423	4777
September	520	2730	2293	9707	229	4771
October	1790	1590	7717	4763	771	4429
November	992	2258	4402	7598	440	4560
December	432	2948	2335	10145	233	4967
January	2215	1165	9664	2816	966	4234
February	2015	1105	8358	3162	835	3965
March	2680	700	11062	1418	1106	4094
April	2502	749	11143	857	1114	3886
May	2431	949	10081	2399	1008	4192
June	2304	1046	9246	2754	924	4076
Yearly	20,577	19,203	87,821	58,959	8,777	52,323

A glance at this table shows us how the outcome or force furnished by the same water stream differs from one establishment to the other, according to the height of the waterfall, and also at the different periods of the year, according to the variation in the volume. The year selected as an example may be considered as an ordinary or average year for the abundance of water. The expense of keeping the water-mills going for an amount of labour equivalent to one horse-power per diem rises from ·037 franc at the spinning-mill of Turckheim, to ·048 at Logelbach, and ·068 at the weaving factory at Colmar. The cost of keeping the steam-engines going for one horse-power per diem is in the same establishments ·910 franc, 1·007, and ·525. The cost of keeping these water-mills going differs little from one establishment to another, and is reduced to a sum altogether insignificant when compared with that of steam. The cost of keeping the steam-engines going, rising from ·525 franc at Colmar, to 1·129 franc at Logelbach, is much more considerable. But as the cost of the outlay of a working day includes, besides the expense of keeping the machinery going, the interest and a sinking fund for the prime cost of establishment of machines and of the original fall, the difference in price between a working day with steam and a working day with water, while still considerable in the spinning-mills of Logelbach and Turckheim, is very much less than the table shows us the working cost to be *per se*. Thus the original cost of five steam-engines at Logelbach, with an actual power of 500 horse, is 415,000 francs; that of water-engines, including the acquisition and appropriation of a waterfall of from fifteen to sixteen metres, is as much as 495,000 francs. At the weaving factory of Colmar the same scale of costs shows 149,000 francs for two steam-engines and all necessary construction, and of 90,000 francs for the horizontal water-wheel, with a fall of 1·50 metres only. Reckoning everything, the water-mills of the weaving factory of Colmar of a relatively high price, not for their working, but for their establishment and the acquisition of the fall, do not present any very sensible advantage over the exclusive employment of steam-engines; but at the spinning-mill of Logelbach the cost of the motive-power for one horse per working-day is 1·17 francs for water-mills aided by steam-engines, while if the steam-engines worked alone, and in a continuous manner, it would be 1·30 francs, including, of course, 10 per cent. for interest and for a sinking fund.

If all these calculations want attraction, they have at least the merit of exactitude, and the further merit of presenting practical results deduced from a prolonged experience. Without entering into further details upon the variability of the prime cost of the waterfall for an equal motive power, we may here bear in mind that this expense is often less than at Logelbach, where the mills are fed by underground canals of considerable length. When the proportion of the prime cost diminishes the working cost, it is necessarily lowered in an equal degree. Thus, while at Logelbach the employment, simultaneous or alternative, of water-mills and steam engines, gives a saving over the exclusive employment of the steam-engine, of ·12 franc per horse per working day, upon a total of 146,780 days of one horse-power, this saving at Turckheim is ·22 franc per horse per working day upon a total of 39.910 days of one horse-power. For establishments able to employ water all the year round, without the auxiliary or temporary assistance of steam, the gain becomes much more considerable, as, for example, in the weaving factory at Orbey, which, with a motive power of from 72 to 75 horse for 360 looms, scarcely costs the proprietor more than ·30 franc for an amount of power equivalent to one horse for a working

day. Add to this that part of the working cost reckoned on the sinking fund, represents in steam-engines the depreciation of the machinery, while this depreciation in the value of the waterfall is almost *nil*, and in all cases sufficiently small. The actual saving as regards water-power is inferior to the calculations indicated above, and we admit them only as a minimum. In effect, the cost of the motive powers in the different cases we have considered, whether in the continuous employment of water without the assistance of steam, or of water with an occasional employment of steam, or of steam exclusively, may be estimated for an average year of 305 working days, and for one horse-power, as follows :—

	Fr.	*c.*
Weaving factory of Orbey, water only . .	91	50
Spinning-mill of Turckheim, water and steam.	317	80
" " " steam only . .	366	0
Spinning-mill of Logelbach, water and steam .	356	85
" " " steam only . .	395	50
Weaving-factory of Colmar, water and steam .	292	45
" " " steam only . .	294	50

In certain cases altogether *nil*, the annual saving sometimes realized by the use of water-power amounts to 300 francs and more for every horse-power employed, when the fall of water remains sufficiently strong all the year round to avoid the occasional use of steam engines. Between the steam-engines themselves the cost of the outcome of work and the expenditure differs much according to the construction, more or less perfect, of the machinery, and the expense, greater or less, of the fuel. The engineers of the Alsatian Association of Steam-engine Owners have taken on themselves the task of determining the conditions of the best outcome of the engines. This association, formed in 1868, under the auspices of the "Société Industrielle de Mulhouse," supplies a much-needed service to the industries of Alsace in assuring the certainty of an examination of steam machinery, and in watching over every possible amelioration of expenditure. The engineers belonging to the association know thoroughly, by periodical visits, the state of all the steam-engines in the associated establishments, and give consultations upon the installation of new machinery, or upon the means of devising a more economical output. A series of most interesting experiments has already been commenced, and is being actively pursued for these ends. The determination of the intrinsic value of the varieties of coal which supply the markets of Alsace, the result of the different systems of furnaces, the consumption of steam in the different kinds of engines for a similar production of power, are so many questions already resolved or in progress of study.

The experiments for the determination as to the intrinsic value of the coals indicate the possibility of a great improvement in the erection of steam furnaces and in the apparatus for economizing fuel. In observing the distribution of the heat produced by the combustion of the coal upon a steam generator, we establish the enormous loss of the original heat, due to refraction and to the cooling of the metallic partitions, or of the stonework in contact with the outer air. Even when the masonry appears in a perfect condition, the infiltration of the air through the body of the stone-work receives a notable proportion of the gaseous products going up the chimney. It is necessary then to endeavour to diminish the causes of loss by modifications in the furnaces, and by the adoption of impenetrable and non-conducting coverings. The employment of interior fires in the furnaces results in a wonderful saving of fuel, surpassing even a proportion of twenty per cent. in the weaving factory at Colmar, where the expenditure of coal per horse per working day of twelve hours scarcely attains 19 kilogrammes. As to the attempts to investigate the outcome of the coals of the different provinces in use in Alsace, the results obtained by M. Charles Meunier, chief engineer of the Association of Steam-engine Owners, is as follows[1] :—

Coal-fields.	Where found.	Nature of the Coal.	Ash per cent.	Steam with rough Coal.	Steam with pure Coal.
Ronchamp .	Ronchamp . .	grasse collante	15·22	7·66	9·06
Saarbruck	Duttweiller . .	grasse collante	16·59	6·84	8·20
	Altenwald . . .	grasse collante	14·76	6·88	8·07
	Heinitz	mi-grasse . . .	9·85	6·98	7·74
	Soulzbach . . .	mi-grasse . . .	13·30	6·69	7·72
	Von-der-Heyd	mi-grasse . . .	13·62	6·61	7·65
	Louisenthal . .	maigre	13·49	6·22	7·19
	Friedrickstha1.	mi-grasse . . .	17·85	6·33	7·70
Blanzy . . .	Monceaux . .	mi-grasse . . .	12·00	6·52	7·41
	Marlborough .	anthraciteuse .	24·42	6·71	8·88
Creuzot . .	Creuzot	anthraciteuse .	15·95	8·13	9·68

[1] *Translator's Note.*—As there is no equivalent in English for the French terms of coal, we are compelled to give this table in its original form.—H. C.

These figures give the proportion of ash left in the grate by the tried coals; the number of kilogrammes of water at 0 degree evaporates at a pressure of five atmospheres for one kilogramme of rough coal, and the weight of water which would be evaporated by one kilogramme of pure coal without ash. As the experiments have been made in a continuous furnace at the factory of chemical products at Thann, with every possible care bestowed upon the heating, the result of the steam obtained under these conditions is superior to the ordinary result in furnaces in which the fire burns only in the daytime. The palm of superiority is carried off by the coals of Creuzot; next come those of Ronchamp, which are chiefly used in our district mixed with coals from the Saarbruck fields. A protracted experiment made at the spinning mill at Fecht, near Logelbach, confirms the results obtained by M. Meunier as to the superiority of the Ronchamp coals over those of Saarbruck, although the proportion of the loss established at Fecht amounts to 20 per cent. instead of the 15 per cent. obtained in the manufactory of chemical products at Thann. The coals employed were of all sizes, small coals and in lump. Comparative trials of small coal and lump coal showed that the relative outcome depends on the nature of the ash, and that the employment of a fuel of inferior quality is advantageous when the number of generators is sufficient to obviate any undue strain upon the fires. From a new series of experiments made at once upon a large scale and at the laboratory, just issued by M. Scheurer-Kestner, manager of the factory of chemical products at Thann, and also deputy of the National Assembly, we see that in the trial of the coals of Bwif and Powell, both from Wales and especially used by the English Transatlantic Company, the amount of cinder is only from 3 to 5 per cent. These coals are slightly anthracite, give forth little smoke, and their outcome in steam in the factory is from 8·55 to 8·64 with rough coal, with a heat of combustion of from 8780 to 8949, noted in the experiments in the laboratory; finally, pine wood used during the coal famine of the winter 1870-1871, at the time of the war, gave 4·29 of steam with water at 0 degree per one kilogramme of wood burned.

By these experimental researches carried on under its auspices, and by the careful supervision perpetually kept over the working of the machinery, the Association of Steam-engine Owners have obtained the best results for the industries of Alsace. Nothing could bear better witness to the practical utility of this work than its gradual extension into the countries round Alsace, to Switzerland, to the district of Baden, to Lorraine, and to France-Comté. Five years ago the engineers of the association had 241 furnaces under their inspection, to-day the number has increased to more than 900. A small cess tax paid by each furnace serves to cover the cost of inspection and experiment. A commission of seven members, chosen from the mechanical committee of the "Société Industrielle de Mulhouse," and renewable every year, watches over the interests of the association, and undertakes the cost of any experiments for which the need is recognized. Every year the chief engineer lays before the society a report upon the work accomplished. The inspectors at every visit give all necessary advice as to the better economy of the steam engines, and examine the interior of the furnaces to discover any hidden faults likely to give rise to serious accidents. The German administration has just decided that the furnaces submitted to these periodical visits shall henceforth be freed from the control of the official mining engineers who are charged in France with this duty. An order of M. de Moeller, governor of Alsace-Lorraine, dated the 21st June, 1872, further authorizes the committee of the association to grant certificates of test by the hydraulic press of the machinery, this certificate as to power of resistance being formerly also given by the official mining engineers.

Thus, the use of steam-engines is susceptible of numerous ameliorations or of a marked saving in the cost of fuel. The water-mills, in like manner, can in many cases give an outcome of power superior to the actual outcome of work by improvements in the fall of water, or in rendering its volume more regular. This regularization of the water-streams by means of reservoirs, which should gather together the produce of melted snow and superabundant rains, to give it out again in times of drought, could be easily realized in most of our valleys. It is owing to such works that the torrent of the Weiss is able to furnish the factories and the mills in the valley of Orbey with a motive power sufficient to work them all the year round without any assistance from steam. Owing to the manner in which the lakes Blanc and Noir, which feed this stream, are blocked up, the supply of the falls, has become regular, sufficing for the factories in all seasons, while the irrigation of the meadows, equally insured by the same works, has improved the position of agricultural matters. The lakes of Orbey occupy one of the finest sites in the Vosges. Imagine two magnificent arcades cut in the sides of the mountains at the height of a thousand metres above the sea, formed by outer walls, having a steep incline, or by rock escarpments. Enormous fallen masses of rock surround the lakes like

a girdle at the foot of the escarpments, or rather lie thickly scattered about the opening of the channels, till the whole looks like some broken stone roadway of the Cyclops' days. A few stunted firs and sorry shrubs, with scarcely a green leaf about them, alone vegetate upon its barren and ungrateful soil. When the midday sun strikes Lake Blanc with its rays, the eye can scarcely bear the reflection from the water or the dazzling whiteness of its weedy basin and its sandy shores. When the storm howls on its peaks, the black clouds rush down into the lakes, and, whirling round and round, seem to tear themselves to pieces upon the jagged rocks with a savage fury. Before the construction of the actual dikes the floods of water produced by the excessive rainfall were dissipated in a few hours, without sensibly changing the level of the lake. In the lower valley the torrent gave rise during three months to overflowings, often disastrous, and during the other nine to a drought more or less intense.

The natural situation of the lakes of Orbey was very favourable to their transformation into reservoirs. Erected at the entrance of the gully through which the water passes, the dikes scarcely measure 25 metres long by 17 metres in thickness, and with a height of 5 metres at Lake Blanc, and 10 metres at Lake Noir, above the normal level. They are composed of two "dry" walls in blocks of granite. The space between these two walls has been filled with large stones, sand, and red clay, containing a decomposition of felspar, which on drying becomes very hard, Another wall of concrete crosses the dam about three metres from the wall-facing opposite the lake, in order to prevent, or at all events to diminish, filtration. As to the efflux of the water, this is accomplished by means of cast-iron pipes solidly fixed at the bottom of the dike. On one side of the lake the conduit emerges in a kind of cage built in a supporting wall; on the other side it is furnished with an adjutage with a sliding sluice valve, which opens and shuts at the end of a chamber, designed also to keep the mechanism from the attacks of frost. The emptying duct, with parallel walls, is prolonged beyond the chamber. The filling duct slopes gradually towards the lake throughout its whole length. Should the whole reservoir be full, the superabundant waters pass away by a superficial incline placed half a metre above the level of the dam, and fitted with a solid slab to prevent undermining. Moreover, a parapet of also half a metre raised at the side of the lake protects the top of the work from the shock of the waves, which the east wind sometimes raises, and with extreme violence, upon the surface of the water. Both dams are constructed in the same way, with this difference, that the work has a greater elevation at Lake Noir than at Lake Blanc, to contain a much more considerable body of water. Together they insure a reserve of about 3,000,000 cubic metres, say 1,800,000 for Lake Noir, 12,000,000 for Lake Blanc, the alimentary basin of Lake Noir consisting of 228 hectares, that of Lake Blanc of 165. In an average year the fall of water furnished by the snows and the rains amounts in this part of the Vosges to 1,500 millimetres, varying from 1,000 to 2,000. Between the waters falling on the surface of the receiving basin and the waters retained by the dams the proportion is that of 25 to 1. This reserve suffices to insure the necessary motive power to the factories in times of dryness; it suffices to insure also the irrigation of the plains during the summer, at a time when, without the construction of dams, the lake would yield no further supply. All this has been done at a cost of only 40,000 francs for the original construction, and of from 3,000 to 4,000 francs more annually for repairs.

Why, after this magnificent result, do we not see analogous enterprises multiplied in all directions? Since the construction of the reservoir at Orbey, made at the instigation of M. Antoine Herzog, the principal of the House of Logelbach, and one of the most enterprising manufacturers in Alsace, there has been some endeavour to utilize the waters of the lakes in the valley of Masevaux and of the lake at Ballon. M. Herzog has drawn up a scheme for a whole system of dammed waters in the neighbourhood of the valleys looking on the border of Alsace. Among the obstacles which prevented the realization of this idea, we may remember the resistance offered by the farmers in certain cantons, and the apprehension caused by the risks to which the establishment of the reservoirs would expose the authors of the enterprise. In the event of the dike breaking, the constructors are held responsible for its damage. But instead of large basins they might content themselves with small reservoirs. The building of small reservoirs, stationed in the valleys from spot to spot, according to the abundance of water and the conformation of the ground, presents evident advantages both for mill-driving and for the irrigation of the plains, without giving rise, like the basins of vast dimensions, to threatenings of a grave change. However, the farmers do their best to hinder these enterprises, and watch with a defiant eye those factories making use of the water-streams. Even in the valley of Orbey, where now the inhabitants are unanimous in declaring the utility of the reserves of water for these irrigating purposes, most of the farmers were at first opposed to the damming of the lakes, under the pretext of such a step prejudicing the plains.

From the inconsiderate manner in which the inhabitants of our valleys often treat these irrigations, we might well believe that each one looks upon the water he cannot personally use as altogether wasted; for the extent of swampy prairie, either infested by rushes or under the influence of excessive dampness, surpasses the extent of land suffering from too great a dryness. In seeking to use up the greatest possible body of water, even to the detriment of rational culture, the peasants appeal to the right given by the Code Napoleon to the dwellers on the banks of unnavigable streams, of employing their water for irrigation. On their side the industrial party, to retain the waters in their channels for feeding their mills, bring forth in opposition the ancient bye-laws of the governor of Alsace, which restrict all irrigations in summer to one day and two nights at most per week, from Saturday evening to Monday morning between the days of St. John and St. James, or from the 24th June to the 25th July. These contrary pretensions excite a lamentable antagonism between the proprietors of the factories and the rural population. On the one part, they contend that if the ancient ordinances originally reserved the water-currents in favour of the factories, or rather, of the corn mills, this measure was taken in the interests of the public, so as to allow the mills to be in a constant state of readiness to supply flour for the wants of the country. A diploma of the emperor Maximilian, bearing date 1494, which limits the duration of the irrigations upon the Logelbach and the Fecht, demands, as cause and reason, the urgent public need of millers' work. On the other side, the existing manufactories do generally occupy the precise position on the watercourses formerly held by mills, the right of fall of which they have acquired. These falls have determined the establishment of the factories; and, as the concession of the mills was not very far back purchased at a price as a personal title, the new purchasers believe that they dispose of a legitimate right, at once authentic as to the falls and as to the volume reserved for mechanical purposes, either by the ordinances of the governors of Alsace prior to 1789, or by the primitive charters of concession. By reason of the exacting demands since the introduction of cotton mills and weaving factories, on the part of millowners and agriculturists, the numerous prefectorial injunctions issued under the authority of a law of the 20th August, 1790, have sometimes purely and simply confirmed the ancient restrictive laws; while sometimes they have modified these laws to include the right of irrigation for several days a week. In fact, the actual legislation relative to the employment of water is almost arbitrary, and requires a thorough revision, capable of defining the rights in a better manner.

To conciliate all social interests, and to regulate them in a true spirit of justice, is the task of an enlightened policy. The advance of science facilitates this task by a readier exploitation of the inexhaustible resources of Nature. Nature offers so many resources still without employment! What wealth remains unexplored, and what powers lost! To speak only of powers, do we not know, according to the calculations of Touillet, that the heat emitted from above our heads by every square metre of the sun's surface is equivalent to a permanent power of 77,000 horse. Without quitting the terrestrial surface, we may estimate the existence in the rivers coming from the Alps of a motive power superior to that shut up in all the coal-pits of England. The strength of the water power of Alsace, as actually utilized, is estimated by statistics at 10,000 horse. Now the water of the reservoirs of Orbey, in its flow from Lake Blanc to the bottom of the valley, suffices by itself alone to keep a power of 800 horse permanently going—nay, 20,000 horse with the volume of water falling at the receiving basin of the two reservoirs, if all this mass descended to Orbey. With a little more care in the management of the waters, agriculture could ameliorate irrigation to any desirable extent, and industry could augment the power of its hydraulic engines. In the same way that the most perfect machinery can never actually utilize all the rough power it has absorbed, so man, in spite of his efforts to utilize the resources placed on his very threshold by Nature herself, will always, at the cost of new endeavours, find the total of accessible wealth superior to the total of wealth already acquired.

THE RESTORATION AND PRESERVATION OF OIL PAINTINGS,

After the Method of Herr Max von Pettenkofer.[1]

I HAVE the honour of calling your attention to a subject which has occupied me for the last two years—the restoration of oil paintings. The results that I submit to your notice are due to the discoveries of Herr Max von Pettenkofer, a famous professor at Munich, who has dedicated to the artists of that town a work entited "Ueber Oelfarbe und Conservirung der Gemäldegalerien durch das Regenerations-verfahren." The second edition of this book appeared last year. Von Pettenkofer has studied all the conditions under which pictures perish, as well as those which are indispensable to their preservation. The microscopic examinations of M. Radlkofer prove that it is in no measure to formations organic or organized, as was formerly suspected, that we should attribute the damage observed in the ancient *Pinakothek* of Munich, and in the galleries of Schleissheim; Pettenkofer was able to discover the causes of the evil, and his theory is confirmed by all who have repeated his experiments, and who, like me, have occupied themselves, and during a sufficient lapse of time, with the restoration of old pictures.

Radlkofer has, then, destroyed an hypothesis that is false; Pettenkofer has created a lucid theory.

I will, in the first instance, give you a succinct *resumé* of Pettenkofer's method; to this I shall append observations which are my own personally, and which go to the support of this theory. I will then make a few experiments, and show you the pictures that I have restored.

It is evident that some colours, even very staple colours, from a chemical point of view are able to preserve their tint and their original brilliancy only on condition that the drying oil which has penetrated them, and in which the particles of colour are, so to speak, suspended, preserves its optical properties. Now, these properties are in nowise independent from the chemical composition of the oils.

The most important property in the oils employed by artists is linoline. This body unfortunately cannot be prepared in a state of purity, and the painters are obliged to resort to either linseed oil, which contains 80 per cent. of linoline, or oil of poppies, which contains only 75 per cent. The linoline, which is liquid when it is pure, solidifies through the oxidation of the air, without diminishing in volume, but in undergoing an increase in weight of about 10 per cent. It is this hard body, transparent like caoutchouc, that holds the colours and the other parts of the oil. It constitutes Mülder's linoxyne.

It is because linoline acquires in the air a consistency invincible to the different temperatures of the atmosphere that the particles of colour, after the drying of the painting, are no longer displaced either by a light pressure, by fatty or etherial oils, or by the varnish.

As in the world there are always and everywhere molecular and atomic movements, so chemical and physical changes follow equally in paintings. These changes are much more frequent in the oils than in the actual colours, because the quantity of oil necessary to make a good colour with a given colouring body is of great importance.

The experiments of Herr Worm of Munich have shown that it is not the specific gravity of the colouring body that determines the absorbable quantity of oil. We might say generally that the colours which contain the least oil are those that change and crack the least. The linoxyne, the product of the oxidation of linoline, becomes by degrees hard and brittle, even when by ether and the etherial oils all the fatty oils, which are non-drying, have been removed.

As to the means employed before Pettenkofer's discovery to renew the physical condition of the colour, it must be remembered that the artist himself varnishes the dry painting to fill the pores which, during his labour, contained oil, and that, after drying, contained nothing but air and varnish. He employs a varnish of resin—a solution of resin in essence of turpentine, or in the fatty and drying oils. These last, however, are very dangerous. After some time the varnish decays, grows mouldy, and will no longer permit the light to pass through. Again and again the varnish is applied, the operation being repeated until it unfortunately happens that the brilliancy is destroyed. To repair the evil there is no means left but to scrape off the varnish and nourish the colour with fresh oil, applying, after the picture is again dry, a new coat of varnish, without mentioning the manipulation with the brush. In taking off the varnish there is no exact measure, and by the oil the picture grows greasy and loses its transparency; more than this, it becomes deep and yellow.

But in what manner, then, should we operate? If we moisten the resin varnish and allow the water to evaporate, the pictures crack and lose their transparency. It is true that we can bring this back again by damping the picture with water that penetrates into the pores, and refracts and reflects the light more powerfully than air, and in its manner of acting approaches resin and oil. But this restoration lasts only until the water again evaporates. By the evaporation of distilled water upon a varnish, we obtain a stain as large in spread as the drop of water itself, and if we repeat this experiment several times the stain or blot becomes as white as chalk. At the Chateau of Schleissheim, Pettenkofer was able to make many very interesting and very various observations, because the walls being covered, some with wood, and in some places not covered, it followed that the pictures were all placed in the neighbourhood of the windows. Those parts of the picture lying in the shade were well preserved; you could even notice the marks of the framework upon which the canvas had been stretched, as well as traces of the paper on which the catalogue number was inscribed.

Pettenkofer has proved that on all pictures there has been a succession of condensations and evaporations of atmospheric moisture, and consequently a loss in the cohesion of the varnish, &c. He has also succeeded in establishing a molecular cohesion by means of alcoholic vapours mixed with air, trying his operation first on a small scale, afterwards on a large scale. At the expiration of forty-eight hours the resin condenses as much as eighty per cent. of its own weight of alcohol, which in a short time it again loses. The resin thus softened is absorbed by the painting, and at the same time the cohesion of the resin and cohesion of colour are found to be re-established. This softened resin affects the colours of a picture much less harmfully than a varnish applied with a brush, for the very rubbing of the brush may occasion a displacement of the colouring bodies.

His plan of operation is very simple. He first makes a trial on the pictures on a miniature scale by means of a little round cardboard box, which is interiorly lined with strong paste, and the end of which is wrapped in flannel moistened with alcohol at eighty degrees; the other end of the box is placed on the picture, which has previously been cleaned. The part thus restored serves as a key of comparison for the attempt on a larger scale. For this they make use of a big box, one end of which is covered with moistened flannel, and in the other the picture is temporarily fixed.

We find in Pettenkofer's work many truly extraordinary cases of the regeneration of colours. Such, for example, is the instance of a green, which, through time and atmospheric influences, had become a greyish-blue, as if the colour had been composed of blue and yellow, and the yellow had disappeared. But Pettenkofer has not stopped there. He has shown us what should be done when a painting has become dull, either from containing no resin at all, or an insufficient quantity to fill up the cracks which have been produced; when the resinous body of a picture is so thick, or so strongly influenced, that we cannot see through it; when a painting is covered with alternate coats of resin varnish and oil varnish, which are affected differently by the blending of air with the alcoholic vapours; and, finally, by which process we can retard or prevent a recurrence of the molecular separation in these restored pictures.

Pettenkofer has indicated a second means of regeneration, through balsam of copaiba, which dries only very slowly, and which possesses a constitution similar to resinous varnish, and resinous solutions of mastic and gum-dammar in spirits of turpentine. The balsam of copaiba ought to have the consistency of a fatty oil, but it should in itself contain neither fatty oil, resin, nor spirit of turpentine. The etherial oil of the balsam of copaiba supplies the optical requirements of the ordinary resin varnish, and may be applied by itself alone to certain portions of a painting without leaving any trace. It fills the pores which are produced in the coloured parts, without any one being able to perceive it, and sometimes even this end is produced by applying the balsam to the back of the painting.

The application of the balsam and the action of the alcoholic vapours ought to be repeated several times, and the regeneration should make the fissures, which have hitherto remained hidden, quite visible; in this case you have only to rub with a small quantity of oil of copaiba, and expose the surface to alcoholic vapours.

[1] A report presented to the "Société Industrielle de Mulhouse," by Dr. Fr. Goppelsroder, Director of the Municipal School of Industrial Chemistry at Mulhouse. (Translated from the "Bulletin de la Société Industrielle de Mulhouse.")

If there is an excess of resin, and especially if the tone of the painting is too yellow, there is unfortunately no other means than to take off this excess, but without destroying the primitive character of the colour;—an operation which should be preceded by the regeneration, which allows the colours to be more easily handled and gives the varnish a more correct consistency. At the same time the varnish has never been completely taken off without deteriorating the colours, because the resin is not only placed above the colour, but to a certain extent incorporated with it.

To take off this excess of resin, the surface is rubbed with a finger plastered over with the powder of colophany, or fiddler's resin, or it is dissolved in oil of turpentine. On the contrary, to fill the pores of the painting with resin, we wash in the first instance with water, then with oil of turpentine, and after having supplied the balsam of copaiba, the portion affected by the alcoholic vapour swells out again.

If the picture contains resin varnish and oil varnish, the first only consumes the alcohol, becomes softened and blends with the colours, while the oil remains on the surface, rendering it dull and even rough. In this case we treat only with balsam of copaiba, pressing it in by means of weights.

A picture regenerated by balsam of copaiba is preserved for a much longer time against the influence of condensation and evaporation of atmospheric moisture.

Time does not permit me to describe to you the very interesting observations made by Pettenkofer in the new *Pinakothek* at Munich, where the molecular separation appears in the proportion of 52 per cent. among the pictures hanging in the galleries exposed to the north, and in the proportion of 10 per cent. only for those in the galleries facing the south.

In every gallery we should study to carefully avoid the formation of dew or the condensation of water upon the pictures, and the most precious—those of true historical value—should be protected by glass. In all paintings on canvas it is well to cover the back of the canvas with balsam of copaiba; then, thanks to this precaution, the cracks that are formed by time will close up again of themselves.

It is necessary, in the first instance, to regenerate by Pettenkofer's method; and, if it is absolutely essential after this to restore still further, the work should be done in such a manner as not to hinder the regeneration which may be again requisite at certain periods.

Pettenkofer's system of regeneration aims at preserving a work of art in its primitive condition, and from time to time of re-establishing the normal optical state of the varnish and the oil. The ancient method of restoration, as Pettenkofer says, could no more compensate for authenticity than chicory could compensate for coffee. It is the task of restoration in the future to preserve in paintings, or restore to them by a physical process, the light and depth of the primitive colours, and to preserve them against the evil influences of coming years. It is then only that restoration fulfils a sacred duty towards the artist. It is incumbent on science to render service to the people of the earth; and can there be a grander occasion than that of preserving the artistic works due to their genius?

As to the restoration of coloured bodies which have, in the lapse of time, undergone chemical modifications, I will not speak here, for it is very much more rarely necessary than that of the varnish and the oil.

I will conclude by showing you a few experiments and a series of pictures, either in train of regeneration or already completely restored:—

1. Here are three glass jars; the first contains pure alcohol, and the other two, powdered copal resin. In one of these jars the resin has remained for ninety-six hours, in the other for seven hours only. Through the action of the vapours of pure alcohol the powdered resin has in the first jar become at once fluid and homogeneous, while in the second the softening of the powder is only just commencing, the resin being soft and homogeneous on the borders of the jar alone. This trial is necessary to explain the action of the fumes of pure alcohol upon the varnish of a picture, and on the balsam of copaiba when it has been applied.

2. Here is a sheet of glass which has been covered with a coat of copal varnish. Upon this sheet I have several times evaporated distilled water at an ordinary temperature, and you see that the spots where this evaporation has taken effect are as white as chalk. This experiment shows us the effect of the condensation and evaporation of atmospheric water upon pictures. In exposing such a coat of varnish, modified in its physical state, to the fumes of alcohol, it becomes again quite homogeneous. We could repeat the condensation and the evaporation of water, and the regeneration by the fumes of pure alcohol, as many times as we wished.

3. This regeneration of the coat of varnish has been executed upon this little picture, representing fruit, a wine glass, &c., and which before its restoration was almost invisible. The restoration has been effected after Pettenkofer's method, but by exposing it at first to the fumes of heated alcohol, then in employing a very small quantity of balsam of copaiba. Before treating it with alcoholic fumes, the picture was cleaned with a brush soaked in the purest oil of turpentine, an operation which has been renewed after the operation to take away the excess of resin.

If I speak here of warm alcoholic fumes, I ought to add that my first essays at restoration were all executed in the following manner:—

Upon a jar of iron or copper I placed a china jar, into which I had poured some pure alcohol. The metal jar constituting an air bath was heated until the fumes of the pure alcohol were developed. Above the jar holding alcohol pictures were suspended horizontally, the various parts of which were successively regenerated by the alternate action of the alcoholic vapours and the balsam of copaiba, where the use of this latter was judged indispensable. The picture was thus placed as near the jar containing alcohol as possible. By these means I obtained very good results. Some sketches in oil without varnish, which had been blanched, so to speak, in the drawers where they had been stored, after being passed several times through the alcoholic fumes, retook their primitive colour, and all their freshness of tone, as if the painter had just finished working.

A few minutes were enough to transform a winter landscape into a landscape of spring time. A faded, tarnished picture which, according to the ancient hypothesis, was supposed to be covered with microscopic organisms, retook, after exposure for a few seconds or minutes to the alcoholic fumes, all its original freshness, and was in every respect perfectly regenerated.

Herr Slückelberg, a celebrated painter of Bâle, and Herr Falkeisen, the director of the Bâle Museum, who assisted at my experiments, were surprised at the rapid effect of these warm alcoholic vapours upon varnished pictures and unvarnished sketches. The use of this warm mixture of alcohol and air is admirably suited for a series of experiments intended to show the spectators, in as short a time as possible, the effects of this mode of regeneration.

It was from design that I left a portion of each sketch or picture in the original state, that is, non-restored, to enable you to appreciate the restoration in the most striking manner.

The use of warm vapours would serve equally well in a regular and serious regeneration, as I have satisfied myself by a series of pictures which I now bring under your notice. This second picture, where the painting could hardly be distinguished, was placed in a corridor at Bâle. It represents a battle between horsemen, and since it has been restored we can distinctly recognize all the figures of men and horses, as well as the slightest details of soil, clouds and sky. Before being restored it was washed in water, and then with oil of turpentine.

In this third picture, representing a forest, roadways, and groups of men, we saw only the vague outline, without any of the details. Now you see it transformed into a picture which has no great value truly, but certainly very pretty, and in which you can perceive all the details and shades in the freshness of primitive colour.

This fourth picture represents the Holy Virgin, angels, the image of God, rocks and trees, and bears an inscription. Nothing before could be distinctly seen but the Holy Virgin and a few other figures; now only look at the effect of the regeneration by alcoholic fumes and the balsam of copaiba! The results obtained in these four pictures are truly astonishing; and they are the same in those other pictures that I am going to exhibit. You will notice that some are charged with an excess of varnish or balsam of copaiba; I shall have to take away this excess, but this operation should not be done until after the regeneration by the alcoholic vapours.

4. Finally, I now open the wooden box, the apparatus for regenerating pictures by cold alcoholic vapours, after the method of Pettenkofer, and from it withdraw that picture restored by cold vapours, which are very preferable to warm vapours.

The box has everywhere been well pasted, the bottom and the edges have been covered with flannel, only once moistened with alcohol, yet this gives off alcoholic vapours sufficient for a whole series of pictures.

Herr von Pettenkofer has rendered an enormous service to the art of oil-painting, to the artists, and to the history of painting, by showing us the way that should be followed to arrive at a really good and thorough restoration of pictures, or rather a regeneration of the normal physical state of the varnish and the colour; a restoration that should from time to time be repeated, according to the circumstances in which the pictures are placed.

After a time, determined by observations varying according

to the individual character of the artistic work, it is necessary to regenerate all pictures. We certainly should not delay until the work of regeneration becomes almost impossible, for then every attempt at restoration supplies only a pseudomorphosis, or even only a simple caricature.

It is useless and needless to plead further in favour of Pettenkofer's method of regeneration ; it recommends itself as much by the splendid results it has furnished at Munich as by its simplicity and its harmlessness.

If I have consecrated much time to the study of this excellent method, it has been because it seemed to me that those who interest themselves in art ought to do their uttermost to recommend Pettenkofer's system to all who possess pictures or who are interested in public collections. Let us, then, wage war against that false and dangerous restoration of pictures which lies enwrapped in an absurd and mysterious veil, and aims at nothing short of a progressive destruction of works of art. Let us continue to seek perfection in the restoration of paintings in following the way indicated by Pettenkofer. This task is in all respects well worthy of the efforts of the "Société Industrielle," which counts among its members many who know how to appreciate the value of artistic works.

RAILWAYS IN INDIA.

THE annual report of Mr. Juland Danvers, Government Director of the Indian Railway Companies, has been presented to Parliament. Besides furnishing, for purposes of examination and comparison, detailed statements relating to the position and working of each railway, a dozen of which are now open, the report contains the following information on the present condition and future prospects of railways in India :—

"A length of 305 miles was added during the year 1872 to the 5,080 miles of line which were open for traffic at its commencement, and during the present year 127 miles more have been completed, so that the railway system now open in India extends over 5,512 miles. Fair progress has been made with the works on the State lines, and during this year between 200 and 300 miles will probably be opened. An additional length of 150 miles on the Oude and Rohilkund line will also be finished and opened before November next. The works on this line which give most trouble are the bridges, especially those over the Ganges at Cawnpore and at Rajghat. The importance of obtaining good foundations below where the scour can possibly reach them has been demonstrated by dearly-bought experience. Hardly a season passes without bridges breaking down and embankments being cut through by the streams they were respectively constructed to cross over and to check. During the floods of last year the Sutlej bridge, on the Punjab Railway, gave way, and on the Northern State line the unfinished works on the Jhelum and Ravee bridges were damaged. Several bridges on the Bombay, Baroda, and Central India Railway were also carried away in September last. 'The fact is,' says Mr. Danvers, 'that when railways were first proposed for India, although a great many difficulties were started which on near approach disappeared, the great difficulty of crossing the rivers and of withstanding the force of the floods was not apparently sufficiently considered or estimated. The rivers of India, which rise in the various mountain ranges some thousands of miles from the sea, cut their way through soils of so soft and shifting a character that in many places a new channel, sometimes miles away from its original course, is frequently formed and the old bed is left dry.' A curious instance of a change of channel occurred last year, when a notification appeared in the 'Calcutta Gazette,' transferring thirteen villages from one district to another, in consequence of the Ganges having so changed its course as to leave them on the south instead of the north bank. The process of erosion is thus described by the late Captain Wood in his 'Journey to the Source of the Oxus' :—'When the waters of the Indus are low, the noise caused by the tumbling in of its banks occurs so frequently as to become a characteristic of the river. During the silence of night the ear is assailed by what at first might be mistaken for the continued discharge of artillery; two, three, and even four reports are often heard within the minute, and even thirteen have been counted in that short space of time.' 'The seasons in India,' Mr. Danvers reminds us, 'have a very different effect upon the watercourses from that which we generally see in Europe. The rainfall is confined to certain months, and, in some places, to certain weeks and days, while the rest of the year is dry and hot. In many cases river beds which may be easily forded and even waded at one season become channels for wide and impetuous streams in another. It was, of course, a part of the engineer's duty to study this characteristic and to provide against the danger. His investigations were, however, thwarted by imperfect data, and what, from recorded information and from observation, was considered to be the maximum volume of water that ever passed through a certain channel in the height of the floods has been frequently exceeded.' Major-General Beadle, R. E., writing very recently concerning the works on the Oude and Rohilkund Railway, points out that in 1870 and 1871 the floods were so excessive and so entirely unforeseen, that the estimates submitted and the project prepared had to be reconsidered and altogether superseded ; the bank had to be raised and the designs of bridges to be revised, increasing largely the waterway. These floods fortunately occurred before the works were much advanced. This, however, has not been the case in other places. Disasters have accordingly occurred and much damage has been inflicted on several railway bridges. Now that more is known, more will be done to avert mischief; but, after taking every precaution, there will always be considerable difficulty where shifting streams have to be encountered, and where foundations have to be laid in soil subject to a scour of 50 and 60 ft. in depth. The only approach in Europe to this condition of things is in the northern plains of Italy, and last year we had an example of how human ingenuity and skill have been unable to cope with streams which rush down from the Alps in the autumn and early winter. With regard to future extensions, we are informed that no new undertakings were sanctioned during the past year. In the present circumstances of railway enterprise in India it is not surprising that the policy of Government in regard to future extensions should be marked by caution. So long as industrial works in India must be undertaken by Government ; or, what amounts to the same thing, so far as financial risk is concerned, by guaranteed companies; and so long as the result of the working of existing lines involves a contribution from the revenue of the country to make up the amount due for interest on the outlay, the Government is right in requiring proof, or the strongest evidence in support of the belief, that future railways, whether undertaken by Government or companies, will turn out to be remunerative in one shape or another. Indirect as well as direct gains, of course, enter into the calculation. The improvement of the material prosperity of the country is the end aimed at through all such works. But if the revenue of the country will not be increased, directly, by remunerative profits from the new lines themselves, or indirectly, by augmented receipts from existing lines, by saving the national expenditure or by improving the national resources, the Government naturally pauses before encouraging fresh works.' As regards capital outlay, we find that the total amount of capital which, on the 31st of March last, had been advanced for expenditure on the guaranteed railways was £91,686,025, of which £1,556,440 was expended during the past official year. The outlay in England for stores and materials was £822,994 ; in India, for construction purposes, £679,446. The expenditure on the State lines is brought down only to the 31st of December, 1872. It had then amounted to £3,492,323, of which £708,827 had been expended in England. A sum of £3,371,218 had been advanced or appropriated to the various undertakings, leaving £121,105 out of the amount expended in this country on stores, &c. to be appropriated in India. The amount appropriated to the State lines during the year 1872 was £1,558,836. The whole capital expenditure on railways in India thus accounted for (which is exclusive of the land for the guaranteed lines and the loss of exchange borne by the Government) is in round numbers £94,500,000. Attention is drawn to the allegation, the truth of which is not denied, that railways in India have cost a great deal more than was expected and more than they will cost in future. The guarantee system, which should only be applied in exceptional circumstances on grounds of necessity, is not admitted to be the cause, and after investigating the capital expenditure of the East Indian Railway, the most important and costly of the lines, the following conclusions are arrived at :—'An analysis of the cost of the East Indian Railway main line, the average of which was £21,100 per mile, shows that a great part of the outlay arose from causes which were unavoidable and of an extraordinary character, such as the Mutiny (which, directly and indirectly, is estimated to have added £3,000,000 to the capital outlay), the Sonthal rebellion, the plan of commencing operations at various parts of the line simultaneously, and the great difficulty consequent thereon of transporting materials by the road or river. The stupendous bridges and the large extent of flood openings, the length of double line and of double way constructed, as well as the general firm and substantial character of the works and the heavy rails and materials used, account also for the rest of the outlay upon what is often erroneously regarded as a single line. Deducting the exceptional expense above described, which can-

not be taken at less than £4,000,000, the cost per mile of single line would amount to £12,250. A comparison between the circumstances of India now and twenty years ago, the greater knowledge and experience which have been gained in the interval, and the practice at present in vogue of carrying out railway works on a light system, will help to explain the difference between the cost of the lines originally undertaken and those now being executed. The recent examples of the Wudwan and Patree branches in Western India encourage the expectation that in districts tolerably easy for railway operations, even with the 5 ft. 6 in. gauge, single lines may be constructed at a cost of from £6,000 to £3,500 a mile.' The revenue derived from the railways during the past year was slightly in excess of the previous year, but the increase is not sufficient to reduce by any appreciable amount the difference between the net earnings and the sum paid for guaranteed interest, which is this year, of course, greater than last year. In 1872 the revenue was £2,869,223. In 1871 it was £2,686,260. In 1872 the gross receipts were £6,351,617, and the expenditure amounted to £3,482,394. In the previous year the gross receipts were £6,146,130, and the expenditure £3,459,870. The passenger and miscellaneous receipts in 1872 were £2,387,003, compared with £2,120,821 in 1871. The goods receipts were £3,964,614 in 1872, and £4,025,309 in 1871. The guaranteed interest advanced by Government during the year 1872 amounted to £4,600,883, so that a sum of £1,734,000 had to be charged upon the revenues of the country. Last year there was a similar charge of £1,740,720. 'Although,' says Mr. Danvers, 'such a result was expected at the commencement of the year, it is no less to be deplored. But it should be borne in mind that some of the guaranteed capital has been raised for and expended upon lines which are not completed or open for traffic. A sum of £6,000,000 may in this way be regarded as unremunerative, so that about £300,000 may be properly deducted from the deficit when it is referred to as illustrating the deficiencies of the present railway system. The last few years are not, it is hoped, a fair criterion of the future. The fluctuations of trade will, no doubt, always produce corresponding effects upon the traffic, but a gradual development is taking place, which will become more rapid as new roads and feeders are made to the existing lines, and new districts are thus opened to the advantages of railway communication. The passenger traffic last year produced £2,085,940, as compared with £1,941,571 in the previous year. The difference of £144,369 was principally made up by the increase in the receipts from third and fourth class passengers, which amounted to £91,385. These classes contributed £1,496,610, or 77 per cent. of the whole. The number of passengers increased from 18,940,585 to 20,332,823. The first and second classes slightly declined. The third class rose from 14,113,436 to 15,126,824, and the fourth, or coolie class, from 3,516,549 to 3,911,429. The increase in numbers which took place chiefly on the East Indian, the Madras, and the Bombay, Baroda, and Central India Railways, has partly been produced by a reduction in fares, which has not yet had time to yield a corresponding increase in the receipts. The third and fourth classes constituted 93·63 per cent. of the whole number. The receipts per mile in 1872 were £400, compared with £394 of the previous year. The receipts from the goods and mineral traffic were last year £3,964,614, compared with £4,022,615 in 1871, showing a decline of £58,000. A large amount of tonnage was, however, carried, 2,929,637 tons having been conveyed in 1872, compared with 2,615,966 in 1871. The falling off in the receipts occurred on the Great Indian Peninsula Railway, which shows a decline of about £156,000 in receipts and 82,143 tons in weight. In cotton and grain alone there was a falling off of 35,500 and 24,000 tons respectively. The number of trains run was 155,594, compared with 131,360 of the previous year. The train mileage was 14,543,862, compared with 14,080,064. The train mileage receipts averaged 8·63*s.*, being just about the same as last year. The highest receipts per train mile were on the Bombay, Baroda, and Central India Railway, where they amounted to 12·51*s.* The mileage receipts on the Eastern Bengal were 9·90*s.*, and on the East India, 9·33*s.* The lowest were on the Calcutta and South-Eastern, being 4·0*s.* Turning to the expenses, it will be seen that the total expenditure for maintaining and working the railways was £3,328,644 in 1872, compared with £3,251,725 in 1871. On the Indus Flotilla it was £53,034 in 1872, compared with £50,325 in the previous year. The expenses per train mile were the same in both years—viz., 4·50*s.* The proportion of working expenses to gross receipts was on the average 53 per cent. This varied, however, considerably on the different lines. On the East Indian Main Line the expenses were only 41 per cent. of the gross receipts; on the Great Indian Peninsula, 60; on the Scinde, Punjab, and Delhi, 86. After alluding to the effect upon the traffic of certain reductions which had been made in the rates, and to the probability of the immediate loss being soon converted into a gain, Mr. Danvers explains the principle upon which he thinks a tariff should be settled. 'A suitable scale of railway charges depends,' he says, 'upon various circumstances, but principally upon the cost of production—*i.e.* of conveyance. There must necessarily be a margin between such cost and the sum paid by the customer, but it by no means follows that the greater the difference the more will be the aggregate profit. In a country like India, especially, where the population is large and poor, it would be unwise to attempt to impose such rates for the conveyance of passengers as would remove the power of travelling from the great majority of the people. The true policy would seem to be to fix a rate, which, while leaving a margin for profit upon the cost of conveyance, would tempt the largest number to travel. If this is the correct view, it can well be understood how, as is often asserted, the interests of railways and of the community coincide. The same remarks will apply to charges for goods, and often with greater force, as, for example, in those cases where water carriage can compete with the railway, and where large tracts of land are kept out of cultivation, or mineral districts are unworked, in consequence of the cost of conveyance to a market raising the price of commodities beyond the consumer's means. Allowance must, of course, be made for variableness of trade, as the average cost of conveyance will in some measure be regulated by the amount carried; but this may be covered in the long run by a moderate margin. The first point to be ascertained, therefore, is what is the cost of conveyance; and this can be arrived at only after a careful examination of the working expenses of a line for a sufficient period to cover different seasons, and to include those influences on traffic which would enable a fair average to be taken. 'A suitable tariff,' he adds, 'however important, is by no means all that is required to insure success in railway enterprise. There is no commercial undertaking which requires more careful study and more intelligent and energetic management than a railway.'"

THE ZINC MINES AND ZINC FOUNDRIES OF THE VIEILLE MONTAGNE.

MORESNET, ANGLEUR, BRAY, TILFF, VALENTIN-COQ, &c.

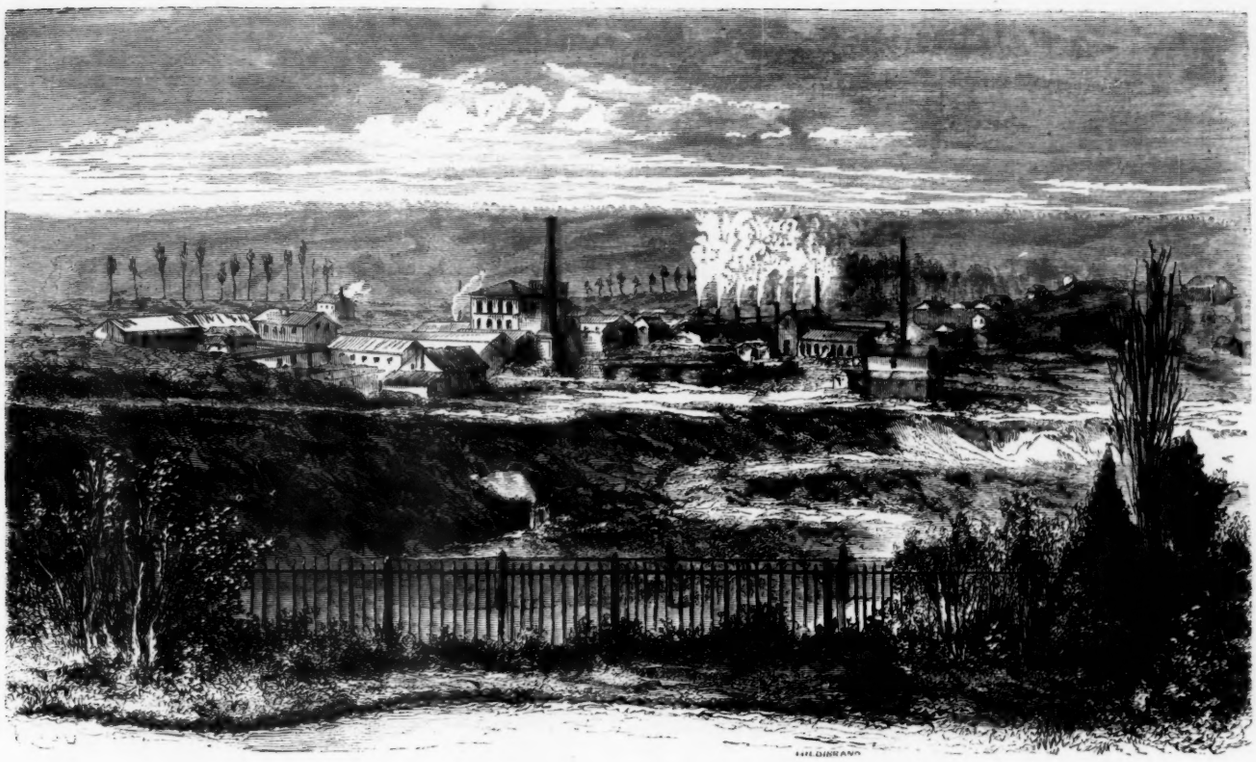
From "Les Grandes Usines," by M. TURGAN.

TO-DAY, for the first time, we cross the French frontier. The powerful company whose manufactories we are going to describe, solely by its own efforts produces a fourth part of one of the most useful metals, a very evident proof of the cosmopolitan nature of its industry. Not only does it claim a right of place in the *Grandes Usines* of France through its fine establishments at Bray and Asnières, but it also, by its foundries at Mülheim and Borbeck, its rolling-mills at Oberhausen, its mines at Bensberg, Uckerath, Mayen, and Wiesloch, deserves a mention in the *Grandes Usines* of Germany. It has also just nationalized itself in Sweden by purchasing important mineral beds at Ammeberg, near Askersund. In England and the United States it possesses considerable agencies for the sale of its products in the shape of sheet zinc and zinc-white, which latter is now so frequently employed in all wall painting. But the principal seat of its operations, the true country of the Vieille Montagne, is Belgium.

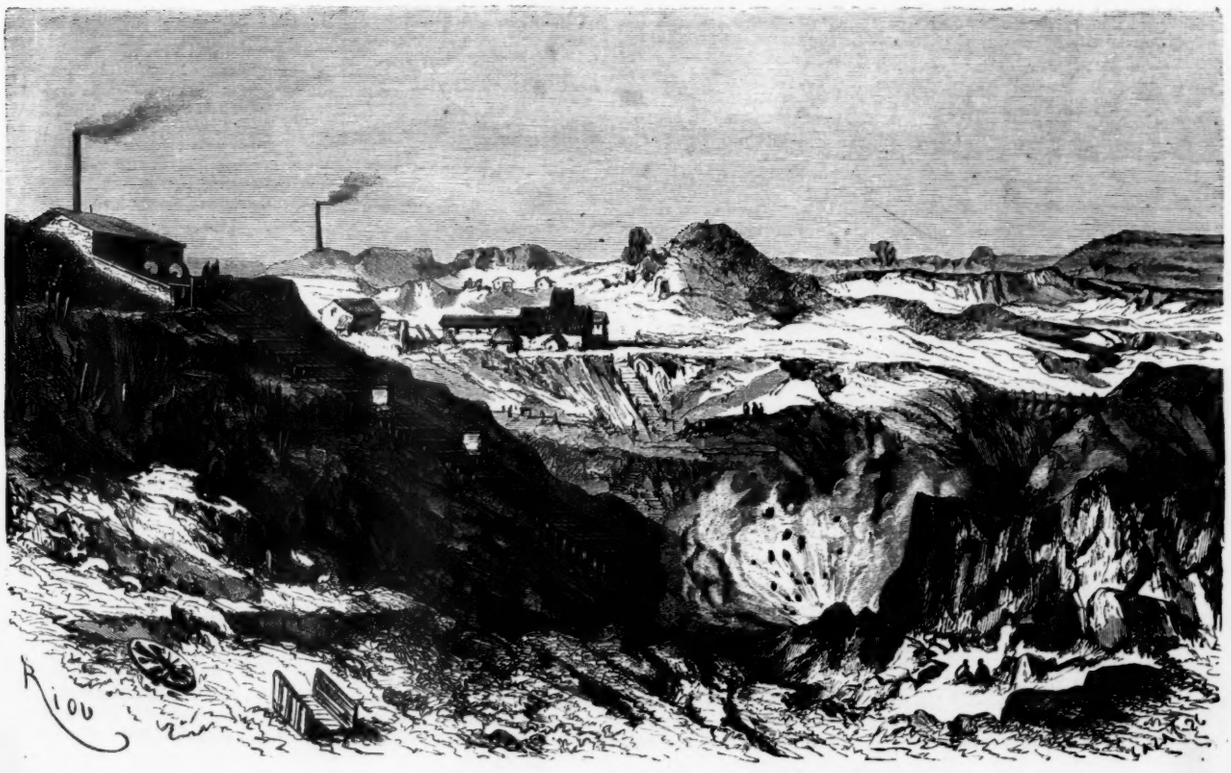
The Vieille Montagne (Altenberg) has been noted in the annals of Limbourg ever since the year 1425, and at present seven important establishments stand upon Belgian soil—at Flône, Valentin-Coq, Liége, Tilff, Welkenraedt, Angleur (the seat of the Société Générale and the Directorate), and finally at Moresnet, a primitive mine which we may include in our Belgian list, though, accurately speaking, this mine forms part of that "No Man's Land" without a determined nationality.

If we were now restricted to the narrow limits of the *Grandes Usines* of France, how could we describe zinc, whether in sheets or in zinc-white, without saying how it was extracted from the bowels of the earth, and how the pure metal is freed from the carbon and silicate that attend it? We have not, then, hesitated to suppress a title which would have been too exclusive, and which the development of our work did not allow us to retain.

We ought first to transport ouselves to Moresnet, where the calamine (*cadmia nativa*) is found in abundance. This spot, turned and dug up during several centuries, has lost every trace of its primitive configuration. Where doubtless there were once green hills, the eye perceives horrible up-raisings of metallic



VIEW OF MORESNET.



ANCIENT BED IN THE OPEN AIR.

yellow earth, which all forms of vegetation seem to shun. The road constructed by Napoleon I. from Liége to Aix-la-Chapelle, crosses the company's establishments; its pavement, which has not been renewed since the fall of that great sovereign, serves as a frontier boundary between Belgium and Prussia. On reaching Aix-la-Chapelle, after having passed the black-and-white-striped masts on the Prussian frontier, we pause for a moment on the top of a hill; we see to the right of the road large excavations, from the centre of which rise smoking chimneys and roofs, crowded together upon a space of about two kilometres. The large intervals that separate the buildings are filled with ores, sorted according to their sizes, and with lumps of coal. On all sides little railways are winding in and out, and upon them the little waggons, pushed by men's arms or drawn by horses, are carrying their loads of calamine towards the furnaces, or are taking from the furnaces, to throw it into the old abandoned workings, that residuum or slag which contains no metal, or from which it would be too difficult to make extraction profitable.

On the left side of the road other rails incessantly carry to the washing-rooms that residuum which still contains a great quantity of useful matter, and which has been accumulated for centuries by the inexperience of the first miners. In this stuff there is a rich and easily workable mine, since there is no question of descending to the bowels of the earth to wrench away a hard and resisting rock to bring to the level of the soil; they have only in the open air to take what they please from the heaps of up-piled matter, soft as it is, too, and of very easy working. The washing-rooms have found a powerful auxiliary in the shape of a stream of running water, which serves at the same time as motive power and separating agent; for before all else the separation of the earth brought up by the small waggons is of the chiefest importance. A fall of several metres, skilfully managed, draws down the water and the earth at once, and passes them through a series of machines, which, according to the size and weight of the fragments, either retains or lets them go through. These, in the first instance, are huge cylinders, like those in which they classify coke; the small pieces pass through the sieve, the larger lumps collected at the lower extremity are almost all good for use.

Here we see again the apparatus we have described elsewhere in treating of the Gas Works at Villette; it is known as the "German chest," a kind of quadrangular bag in which the water, strongly shaken, enters by the bottom, and raises in order of lightness the sand and the pebbles placed in the chest. Skimming off the surface, they can take away the almost valueless dross, and then the metallic sands are visible, being easily recognized by their weight and their orange colour. These chests are watched by women, who fill and empty them, and regulate the movements of the water. The noise of the scraping of the sieves, and, at regular intervals, the dull and solemn stroke of the piston which smites violently on the water, the incessant movements of the women, gathered together in a small space—all these give the workshop a special physiognomy, which renders the appearance of the water, which inundates the ground and flows around you on all sides, still more strange and original.

The sand, taken from the upper part of the chests, is not even then considered as wasted; to discover the metallic particles they make use of an endless cloth, submitted to a stream of water, which carries away the light and sterile portions; these cloths are moved the reverse way to the stream, bearing in their ascensional movement the rich and weighty particles to boxes prepared to receive them. Finally they bethought themselves of using great circular tables, upon which a continuous current, starting from the centre, falls over the whole surface, and gently stirs and moves the sands that are to be washed; the water carries off the light parts, the mineral remains on the table, and is swept into the receiving boxes by brushes. This series of operations affords the best results, and furnishes about a fourth part of the mineral required for a demand that is incessantly increasing; it is, indeed, one of the great difficulties in metallurgical exploitation upon a sufficiently large scale to maintain a constant proportion between the extraction of the ore, the calcination of the calamine, the reduction of the metal, the rolling into plates, the production of zinc-white, and the public demand. The water that has been used in this washing passes through a series of basins in which it deposits the sand, from which they still find a way to extract some more metallic particles.

To the earths of former excavations the calamine earths extracted from workings actually in progress are added in the washing-rooms; as to the larger lumps, they are heaped in the court-yards, where they remain for several months exposed to the air, the influence of which causes the surrounding clay to peel off and fall to the ground. At Moresnet they work nothing but calamine or carbonate of zinc; some other of the society's mines yield blendes. The treatment of these we shall study later on.

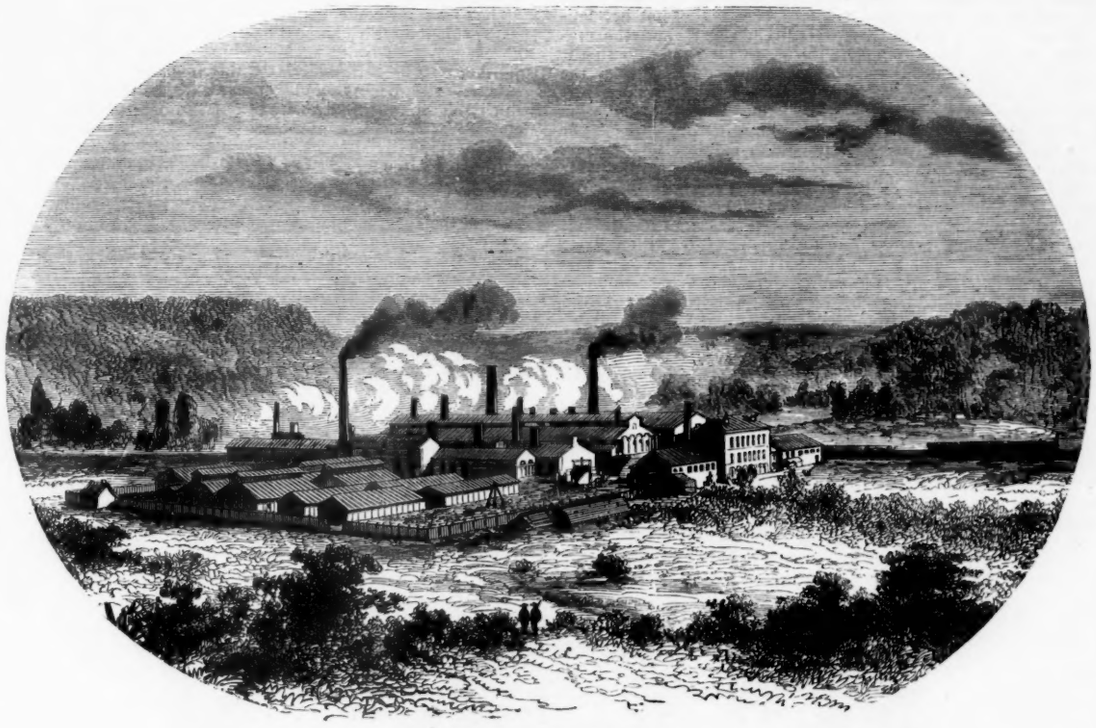
The beds from which the ore is extracted are not very deep; formerly they merely turned up the soil on the side of the hill to the right of our road; but now they are compelled to sink shafts of about one hundred metres deep to reach the beds of calamine buried in the earth. Certain difficulties interfere with their working; faults are very frequent, and the breaking in of the water often stops the labour; the galleries are so damp that the miners dress entirely in leather. The rock that separates the bed of mineral from the shaft is extremely hard, and, to hew out a gallery of 90 metres long, they are obliged to have recourse to those borers, driven by compressed air, which were employed to pierce Mont Cenis. A large water-wheel sets the compressing pump in motion; this wheel receives the water from above, and is surmounted by a very ingenious regulating apparatus, which we never saw anywhere else, and which is identical with the conical ball pendulum of the steam engine. When the pressure of the water is too strong, the speed of the wheel is increased till the balls of the regulator spread out, driven by the rapidity of the motion, and act upon a lever which lowers the admitting valve, and of course diminishes the supply of water. When, on the contrary, the water flow is not powerful enough, the centrifugal force ceases to drive the balls, which droop towards their axis, and thus open the valve, and give admittance to a greater body of water. We recommend this ingenious innovation to every owner of water engines who may require a regular power.

The calamine, once washed and freed from its attle, is placed in the large furnaces in layers alternating with layers of finely cut coal, heated sufficiently to free it from a portion of the carbonic acid and the whole of the water, but not enough to render the metal volatile. This calcination is made in two methods, according as to whether the fragments are large or small; those of 0·04 centimetres and above are burnt in a lime kiln, while the little pieces go to the air furnace. After this burning the ore is despatched to the Belgian workshops, to the reducing furnaces used to free the metal. Thanks to the railways that connect the factories with the mines, this carriage does not add much to the cost; they should, as much as may be possible, send on in advance the proper quantity of fuel, for it requires from two to two and a-half parts of coal to reduce the metal.

For a very short time only has zinc in its pure state been known as a metal. Its useful properties have always been applied in the different alloys, especially in the manufacture of brass; but they were never able to reduce it to a pure metallic state. The best chemists of the last century termed it—"a demi-metal, which in its regular state approaches most of the metals by its semi-ductility, or the kind of malleability of which it is susceptible." They really had, but very rarely, Saxon, Swedish, or Indian zincs, and they imported little ingots of a large crystallization, under the name of *toutenague* or *tintenague;* when they wished to make brass they chose the palest calamine, and that least charged with oxide of iron, and smelted it with red copper. The reason of this difficulty in collecting the metal lay in the extreme aptitude of zinc to ally itself with the oxygen in the air, and to form flakes of oxide of a snow-white colour, which the ancients termed *lana philosophica*. The oldest way of collecting the metal was to enclose the calamine, placed in layers mixed with wood charcoal, in crucibles, perfectly sealed, and cemented in the upper part, and open at the base with a spout and a gutter to carry the melted metal into a mould of charcoal powder; they then called it *rauli*. After a second fusion they cast it in square cakes, and it then took the name of *zinc arco*. This process, known as *per descensum*, is still used in some countries, notably in England.

The process at Angleur is exactly contrary to the above, and was discovered in the year 1780, by a Liége chemist, the Abbé Dony, who, in some little experiments in his laboratory, tried, by distillation, to obtain metal from some calamine heated in his crucible. As soon as the zinc came into contact with the air the *lana philosophica* spread itself through the laboratory; to prevent this expansion the abbé stopped the mouth of his retort with a little flower-pot having the usual hole. He still lost much of the oxide of zinc, but he deposited the metal in the lower concavity of the pot. This was the origin of a considerable industry which now annually consumes more than 100,000 tons of zinc in the different ways that we have more recently discovered for its use. An imperial decree, dated 1806, determined the concession of the mines of the Vieille Montagne. Purchased in 1815, by M. Mosselmann, they were worked with an intelligence and an activity that have become traditional in the annals of this great industry.

The seat of the Société, founded in 1837, and the centre of its operations, is at Angleur, a large plain covered with considerable buildings, crossed by the great railway line from Paris to Cologne, and including the station of Chenée. This same line unites Angleur with Antwerp; while the Meuse, which bathes the walls of the workshops, connects it with Prussia, Belgium, Holland, and, consequently, with England. The lofty intelligence which



VIEW OF ANGLEUR.

presided at the selection of the site has also guided the interior arrangements of the factory; a series of planes, fitted with rails, facilitates the carriage of the ores from the railway to the mills which reduce the metal to powder, and from the mills towards the furnaces, or are useful for despatching coal in every direction where it can possibly be wanted. By the side, and on the plain opposite the Meuse, stand a pottery and brick-making works, the almost invariable accompaniment of every metallurgical factory, and which at Angleur forms one of the most active divisions of the whole. On the side opposite the railway stand the buildings occupied by the administration, as well as the apartments of the manager, looking upon a charming valley, whose rural beauty forms a striking contrast to the arid spot devoted to the active working of the metal.

As we have just said, the pottery, where crucibles, pipes, bricks, and pieces of furnaces are manufactured, forms an important part of the whole concern. On the good manufacture of these different pieces the success of the reduction of the zinc depends. Thus the Société has preferred rather to perform the work itself than to purchase the pieces ready made from special establishments. The clay is brought from the Ardennes, and they endeavour to compose as tough a mixture as possible; the clay also serves as a cement for the broken crucibles. We have elsewhere described the process of brick-making, which is much alike in all establishments; but we will, however, note here a most ingenious patent machine for boring the cylindrical crucibles made after the Belgian fashion. With a full mandril, you stuff and cram a cylindrical mould with plastic clay; then you replace the mandril by a long turning gouge, which, penetrating, little by little, into the mass, pierces the clay in the middle, while compressing and strongly moulding upon the sides all that clay it does not reject from above; reaching 0·02 centimetres from the bottom of the cylinder, its course is arrested, and it is pulled straight up; there is nothing more to do than to take the crucible thus obtained from the mould and let it dry. This process, admirably adapted for the little round crucibles on the Belgian system, cannot be employed for the high retorts, formed like the muffles of the Silesian furnace.

These muffles are made by hand in precisely the same manner as the muffles of Sèvres and the crucibles of Saint-Gobain. The crucibles and muffles are manufactured with the most careful attention, the crucibles especially, for their length is more than one metre, for a diameter something under two decimetres, and a thickness of at the most twenty-five millimetres. These crucibles have to bear a temperature of 1,200 degs., being supported only by the two extremities, and containing twenty-five or thirty kilogrammes of mineral matter; thus breakages are very frequent, in spite of the care brought to bear in their manufacture, and to the management of the furnace. The least crack would afford a passage to the extremely volatile oxide of zinc; on this account they ought to be perpetually examined and re-examined, and the damaged crucibles luted with clay specially prepared. Often, again—and there is no remedy for this—some fragments of smelted attle are found in the mineral powder, which pierces through the crucible like a gimlet, and lets the metal flow out; thus the yards, in the midst of which stand the reducing furnaces, are themselves full of damaged and useless crucibles, of which some parts only are utilized in making cement. The rest are used up as macadam; and the ends only, generally varnished over by the heat, are excellent material for outer walls, and give the enclosures here a very singular appearance.

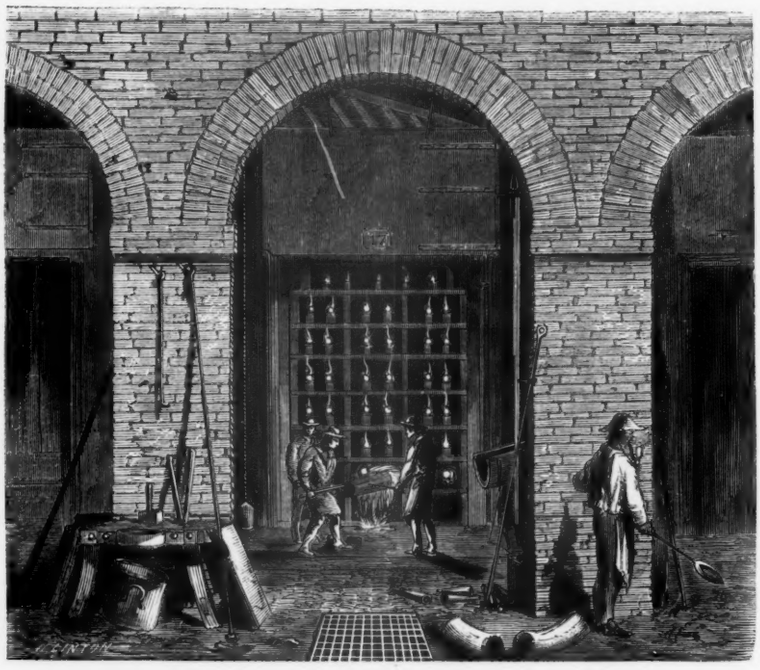
The system almost exclusively employed at Angleur is the "Belgian system;" but several furnaces, built now for some time past, are being thoroughly experimented on, and have already yielded very fair results. These furnaces are "mixed," that is to say, in their lower parts they have muffles, keeping the crucibles for the top. The furnaces—huge quadrangular blocks—are placed in line in the middle of a large hall opening to the yards beyond by large embrasures communicating by lines with the railway system, which threads all through the yards; each furnace is composed of an interior fire, and of a chamber in which the crucibles are suspended, slightly inclining backwards, and held at their two extremities by projections on the sides of the furnace; their orifices are pointed towards the entrance of the chamber; on that side there are strong pieces of iron, cast in one piece, which form the bars of the furnace, and which are protected by clay against the violence of the fire. The chambers, varying much in their holding capacity, receive from forty to eighty crucibles; the furnaces are put back to back, and four to four, so as to form a massive block, with one central chimney in common, which carries off the products of the combustion. When the furnace has been well examined, and has been finished in a satisfactory manner, they begin by heating it red-hot, which is continued for about three days; then it is

fitted with the crucibles, also brought to a red-heat in the little furnaces; all these different crucibles are solidified with clay; the orifices are closed up with plugs of clay, but not hermetically sealed; the fire is stirred for twelve hours, and the crucibles are then ready to receive the ore to be reduced. In the workshops at Angleur, Liége, Flône, and Valentin-Coq, the calamine brought from Moresnet or Sweden is treated in the same manner as that coming from Spain, where, for some time past, important beds of calamine have been discovered.

It has already been reduced to powder in powerful crushing mills; a little waggon carries it to the workman whose duty it is to bear it to the furnace, while another little waggon brings him the coal (uninflammable coal, *houille maigre*), broken as small as possible, which he smashes up and mixes in an iron trough with the calamine powder, moistening the whole with a little water. He then takes in a little ladle with a long handle 30 or 40 grammes of the mixture, which he throws into the botttom of the crucible, going on with the operation until the crucible is full; this charging lasts for four days; when it is finished they add to the crucible, what has replaced Abbé Dony's flower-pot, a kind of truncated cone, large enough at the base to hold the neck of the crucible, and fine enough at the end to prevent more than about six centimetres of gas passing through the orifice.

They now raise the temperature; the water mixed with the paste evaporates, the charcoal blends with the oxygen, and every tube is penetrated with a flame, which passes from red to blue and then to a greenish-blue. At this moment a few flashes of metallic oxide begin to appear; to avoid the considerable loss which this would rapidly cause, they cap the tube with another joint of iron, which allows the gas to escape only through a very tiny opening; by degrees the decomposition of the calamine takes place; it is formed of the carbonic acid and the oxide of carbon, which carry along with them the drops of metal. When they reach the mouth of the crucible the vapours cool down in the tube, condense, and little by little form a bath of liquid zinc covered by a thin skin of oxide. The extraction of the metal takes place at fixed hours, and demands much skill and practice on the part of the workmen. The slightest neglect might allow an escape of the vapours, which would burn away in contact with the air, become oxidized, and diminish the quantity of the metal.

As a premium is given to the hands who require the least possible quantity of ore for the same weight of metal, the workmen are themselves interested in taking all necessary precautions; these consist in gathering the metallic powder from the additional iron joints, the orifice of which they are careful to close with a damp rag, to avoid inflammation; then with a small special instrument the workmen search in the tube for the liquid metal, which flows into a kind of iron saucepan, with which they empty it into the ingot moulds, bearing at the bottom of the matrices the different brands necessary for the classification of the various productions. This operation, renewed three times, at intervals of three hours to four hours, gathers all the zinc contained in the ore, and soon the jet of flame changes from green to violet, and goes out. The tubes are then detached, and the dross which remains at the bottom of the crucibles is emptied out. It is now that their faults are most visible, and that the workmen proceed either to repair them or to replace them with others; for during this time the furnace cools down, and the hands, having a premium also upon the fuel, have every interest in not burning more than they can help to raise the temperature again to distillative degree.



THE BELGIAN FURNACE.

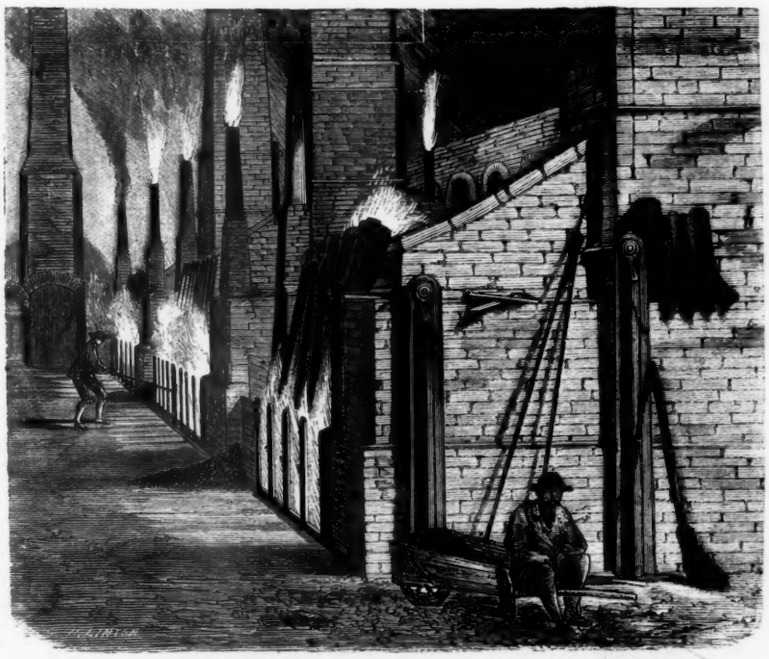
A furnace lasts about six months without repair, but almost always at the end of two years it is necessary to rebuild it, for it is never left in repose, and as soon as the crucibles are empty and cleaned they change them anew, and the series of operations recommences. It is evident that if the quantity of metal obtained depends in a great measure upon the good quality of the crucibles, and the skill of those who manage them, it also depends much upon the ore itself. The calamine of Moresnet, like the Swedish blendes, yields about 50 per cent. of zinc, of which a very small part forms in the joint-tubes in the shape of metallic powder; the Spanish blendes give sometimes as much as 55 per cent.

The Silesian muffles are much larger than the Belgian crucibles, being at least one metre in length; they are more than 30 centimetres high by 80 broad, and are made precisely like glass furnaces. As in these, a low roof covers them in and concentrates the heat which comes from the interior fire, as in the Belgian furnace. The operation of working does not differ much from the Belgian system, except in quantities and dimensions. In short, they heat in the same way, whether with the furnace or the muffles, and these latter are charged when they have arrived at a brilliant red-hot heat; only, instead of four days, twelve days are required. Then, in lieu of the little tube for collecting the metal, there is a large box of burnt earthenware, after the fashion of a leg, in the calf the zinc condenses, while the gas escapes at the foot. A joint of an iron spiral caps the box. The metal deposited here is collected in the same way as before, with a ladle.

These two systems, both based on the process *per ascensum*, divide the favours of metallurgists. Taught by experience, the Société use one or the other alternately, according to the richness of the ores and the greater or lesser value of the fuel. Thus, at Valentin-Coq, where the furnaces are erected upon the coal itself—the shaft, indeed, is situated in the yard of the factory—they have established the Silesian furnace, while at Angleur, under the very eye of the directorate, where the most skilful workmen are concentrated, the Belgian system is generally employed.

The zinc obtained either by the Belgian or Silesian furnaces, and from blende or calamine, is sold in a rough state to the trade in the form of pigs, flat, broad, and thick, and of various degrees of purity. Rough zinc enters into different alloys, such as brass, and is employed for several purposes, the most important being the galvanization of iron, which is executed by passing through a bath of molten metal the wire, bar, or plate which it is desirable to protect from oxidation. The greater part of the telegraph wires are made in this way. The output of rough zinc from the company's furnaces is about 25,000 tons annually; but it is not under this form that most of the metal is sold, but in the shape of sheet-zinc. Of these 25,000 tons, about 3,000 are rolled at Oberhausen in Prussia, 10,000 at Angleur and Tilff in Belgium, and the remainder at Bray-sur-l'Epte, near Roche-Guyon (Seine-et-Oise). It is in this last factory that they make the galvanized wire and the joint-protectors that we shall describe in our account of the rolling. The position has been chosen on account of a waterfall of more than 100 horse-power, which, except in times of summer drought, suffices to supply the great power that the rolling-mills require. The buildings are admirably designed, in a true industrial spirit, large, open, low, and consequently not too costly; they are fitted with railways and every convenience, like all the workshops of the Vieille Montagne. A fine "Poncelet" wheel, 6 metres in diameter, with float-boards of $2\frac{1}{2}$ metres, is enclosed with three other ordinary wheels in a huge covered shed, which they can wall in at the sides with doors and windows. This precaution affords during the depth of winter an immunity from the destructive damage of frost; for they light large fires on the stone platform which stands in the midst of the four wheels. The water machinery, although very pretty, ought to be supplemented by a steam-engine, which, in the time of low water, would bring a much needed assistance.

The metal comes from Liége by the Northern Railway, from



THE SILESIAN FURNACE.

Antwerp and Rotterdam by water, and by the Eastern Railway; the coal coming from the Seine is unloaded at Roche-Guyon. The zinc cannot be rolled in the state in which it arrives; it requires to be liquefied anew, and in some sort purified. This operation, although very incomplete, frees the zinc from the greater part of the metals heavier than itself, as lead and the slag and oxides which were formed in the first and second melting. This latter operation takes place in somewhat complicated air furnaces; the bottom is inclined in such a way that the liquid bath may be much deeper at the end where they collect it than at the other end, where they place the ingots; three doors close this inner chamber; three doors, all furnished with sliding valves, permit the collection of the molten metal, while admitting the cold air into the interior of the furnace; the operation is then continued, and as the bath is emptied they throw in new pigs, which soon raise the level. The furnace contains 2,000 kilometres of metal.

The fusion heat varies from 460 to 500 degrees; hotter or colder, the metal would be of a pasty consistency, and would not possess fluidity enough to flow; it is, in short, analogous to the maximum of the density of water. From time to time, with a long poker terminating in a kind of concave pallet, they skim off and take away, through one of the doors, all the matter floating on the top of the metal, various oxides and impurities, which are put carefully on one side, for they still contain more than 50 per cent. of their weight of zinc, part of which is extracted in the same workshop by a passage through the heat; the rest, irreducible at the ordinary temperatures, is sent to Angleur, to be treated by the high temperature of the reducing furnaces. Seventy-five per cent. of the useful matter is thus withdrawn, and, finally, the loss is reduced to about $\frac{1}{2}$ per cent. As to the lead and the metals heavier than zinc, they are gathered in a cupola arranged in the lower part of the ground; with a scoop they ladle up the mixture of zinc and lead from the cavity. When they wish to separate the two metals they re-melt the mixture and allow it to cool in a mould; the zinc solidifies first, and they have merely to pour out the lead, which is still liquid and does not settle for some time.

The zinc, purified by these different operations, is more or less fit for rolling as it is more or less pure from metalloids; thus the zinc made from blendes always contains a little sulphur, and is more easily rolled than the product of calamine; they are, therefore, careful to mix the zincs from the different provinces, according to the thickness of the sheets to be made.

When the bath has attained the desired fluidity, the casting begins. They cast into quadrangular moulds of 0·70 long by 0·23 broad, and of a depth varying with the thickness of the sheets they wish to make; these moulds are borne on a metal

tray turning on an axis, which presents them to the filling orifice one after the other; there are about twenty-five moulds on the tray. A workman stations himself inside, armed with a ladle, with which he skims off the pellicule of zinc, while a second workman pours with an iron scoop the molten metal into a cavity at the top of each mould; the twenty-five receivers are rapidly filled, and with such a sureness of hand on the part of the casting workman, that the sheets weighed on coming out of the moulds differ from each other almost insensibly. These sheets, placed on large carriages, are cold in about two hours, varying with the season, and are carried to the first rollers to be beaten out. The rolling-mill consists of two cylinders of cast steel of 0·52 centimetre diameter by 1·26 metre broad; a brake arrests the fall of the upper cylinder after the passage, and a powerful vice, easily handled, lets one approach the other by increasing the pressure. Each sheet is rolled out one by one in a series of successive passages, graduated according to the resistance of the metal, which spreads out in both directions, especially in that perpendicular to the axis of rotation.

When the sheet is sufficiently drawn out, the rolling workman doubles it adroitly with his pincers, so as to present the edges of the two extreme borders to the cylinder; the whole is flattened out in passing through, and the sheet is regularly cut the whole length of the fold. Twenty passages finish the rolling out here, and the sheets are then taken to be squared to a neighbouring table, fitted with guides, which determine the dimensions; this squaring of the sheets is performed by a pair of huge shears, which cut the metal with a perfect evenness. The rolled-out sheets are removed to the annealing boxes placed on the furnace, so as to utilize all the lost heat; when they are sufficiently reheated they are made into packets of 18 sheets at most, 6 sheets at least, according to the thickness of the numbers they wish to produce, a thickness extremely variable, for it differs from ·0045, that is to say, four millimetres and a-half, weighing 2·90 kilogrammes per square metre, a size that takes in trade the title of "No. 9," up to "No. 26," which weighs 18·18 kilos per square metre, and of which the thickness is ·0266. This last packet weighs about 100 kilogrammes.

The packets of sheets are carried to the rolling mills, properly so-called, arranged like the hammering-out cylinders, which, by compressing the sheets in a series of passages, enlarge and spread them out to the desired dimensions. During the rolling they are careful to divide and turn the different sheets in the packets, so that they shall all one after the other be in the middle in passing through; the sheet placed in the centre, receiving the maximum of pressure, spreads out more than the others. In spite of these precautions, and spite of the care that has been taken to cast them of the same weight, and, after beating them out, to cut them of the same dimensions, no two sheets of rolled zinc are ever exactly the same size or weight. Leaving the rolling mills, the sheets are squared anew upon a table, with guides as before, and provided with circular steel saws which take off the uneven edges, and size the plates according to the dimensions required in the trade. After having been squared the sheets are examined by a skilled workman, who stamps them if they appear to him sufficiently good, and rejects them if they exhibit faults; the cuttings and the rejected sheets are remelted with the rough metal, and go again through the different processes. The accepted sheets, when they are very fine and very well made indeed, are selected to be used for the purpose of glazing paper. The selection takes place in a special room, where workmen armed with gravers take off the slightest imperfection from the chosen sheets, of which the sale begins to be very important. They are then packed in cases lined with soldered zinc; the ordinary sheets are packed in huge chests, similarly lined to prevent the introduction of humidity.

The bulk of the zinc sheets rolled at Bray go to Paris, to the central dépôt of the Société; the rest are sent to Havre, where they are put on shipboard for foreign ports; a portion is employed in the ports for sheathing vessels, but to fasten the metal upon the wood, they should never use iron or copper nails, which, coming into contact with the zinc, immediately develope galvanic influence and rapidly destroy the sheathing. It is essential, then, to have nails of the same metal, and for that purpose an ingenious machine has been invented which, with one blow, forms the nail—point, body, and head.

They begin by preparing small bars as broad as the nail should be long; they roll them out in a special little rolling machine, and each bar is placed one after the other in the two prongs of a fork terminating in a long iron rod; this fork, balanced so as to rise without effort, carries the zinc bar to a little guillotine chisel which cuts it obliquely; the little morsel of triangular cut metal falls into a kind of matrix, the jaws of which close towards each other, so as to hold it, and it receives on the broadest side the pressure of a little cap, which flattens it out and forms the head of the nail. The matrix re-opens, drops the nail into a lower receiver, and then closes again upon another fragment. An adroit combination causes the bar of zinc to turn each time, so as always to present the broadest side to the ring or cap that makes the head.

Another machine for manufacturing large nails is composed of two lateral jaws armed with an edged die, whose edges give a sharp point to a small cylindrical fragment, while a cap is lowered to strike the other end of the fragment and form the head; for the large nails, thick zinc wires are cut for use instead of the bars.

The wires are made in the same way as the nails, in a little out workshop at Bray, joined to the chief factory by a railway, and utilizing the fall of an up-stream at Epte. To make the wires they begin by melting the rough zinc in the smelting furnace above, only they cast it in close moulds yielding bars, instead of in open moulds yielding plates. These bars are heated in the furnace and then passed through the grooves of a roller, which reduces them to about the thickness of a finger. The long piece of metal is then taken to the drawing-frame, which begins by scraping it, and mechanically facing it in its inverse way, through the first wire draw-bench, whose sharp edges face its surface. It still goes through a series of wire-drawing machines, decreasing gradually in size, even as fine as a horse-hair.

In this same workshop they also make the joint-coverings by means of a stamp which indicates the gauge of the convexity, and of another beating-out machine which models it upon the whole surface of the plates; two rollers placed at the opening of the beating-out machine facilitate the motion of clipping through. At Bray they also make fluted sheets of zinc, an arrangement that gives much strength to the metal, and allows a great economy for roofing purposes. Passing the sheets of zinc between two cylinders with round grooves, they obtain by degrees alternate concavities and convexities perfectly regular; but they are obliged to work very gently, or the metal would be torn and rent. Fourteen passages are necessary to gradually attain the complete fluting. Like other establishments of the Vieille-Montagne, the factory at Bray includes all manner of institutions that can augment the welfare of the workmen; but it possesses, which most of them do not, baths open to the workmen at 15 centimes, and to the clerks at 30. They have also tried a good plan which ought to be imitated in all large works subject to times of idleness. Firmly convinced, both through humane principles and through their own true interests, they do not in time of the low waters dismiss any of their skilled staff, but employ the hands in building houses which cost them nothing save for material only. Each of these houses lodges two families, and each part consists of a large cellar in the basement, a good kitchen and a dining-room on the ground floor, then, on the first-floor, two bedrooms and a little sitting-room, and a large attic over all. As such a house costs only 3,000 francs, the company can let each half at 75 francs per annum with about 10 *ares* of ground (one *are* = 100 yards square), in which the fortunate tenants can raise magnificent vegetables. As each large factory is now supplemented by workshops for blacksmiths, carpenters, and locksmiths, the only workmen from the outer world required are joiners and painters, and even these they are able in most cases to do without. The outlay for wages is undoubtedly increased; but the company have retained intelligent workpeople, and, giving them good and commodious lodgings at a cheap price, they have rendered them more willing and able.

We are now going to follow the zinc, extracted from the mineral ore, cast in pigs, or rolled in sheets, in its different industrial applications, ever becoming more and more varied, for day by day new methods are invented of utilizing this precious metal. One of the common purposes to which it is applied at present is the manufacture of zinc-white.

The Société de la Vieille Montagne, although occupying themselves chiefly with increasing the general uses to which the metal they produce can be put, have still, at all events in part, maintained the manufacture of zinc-white at Mülheim in Prussia, at Valentin-Coq in Belgium, and in France, at Asnières, a model factory founded to prove and encourage newly invented processes. M. Payen, in his "Chimie Industrielle," thus describes the beginning of this industry:—

"Although the improvements we have just indicated have, in these later times, considerably lessened the dangers that were inherent to the preparation of white lead, there still remained many causes of unhealthiness in its manufacture, as well as in its general employment, especially in painting. Courtois, the chemist in the laboratory at Dijon, about the year 1780 proposed to substitute oxide of zinc for carbonate of lead. Guyton Morveau, in 1783, in a dissertation ('Mémoires de l'Académie de Dijon'), established the comparative advantages that zinc-white possessed in painting over white lead, on the score of health. He had already prepared the oxide of zinc by the humid way, and by the combustion of the metal with the assistance of a crucible

placed in a crevice in an air-furnace ; and he divided the zinc flowers from the metallic particles by means of a wet separation. His manufactory was established, tolerably good furnaces employed, and several applications for the purpose of painting were realized. In 1796, Atkinson, of Liverpool, took out a patent for the same industry, which in France, as in England, was hindered and stopped from several causes. These first attempts had fallen into oblivion when, in 1849, M. Leclaire, an old workman formerly employed in the manufacture of colours, occupied himself anew with the subject, and with more success ; to him is due the actual foundation of the industry of zinc-white and the colours having that oxide as a base. This new industry is remarkable at once for its great importance and its extreme simplicity.

" Metallic zinc in pigs constitutes the primitive matter, and you have only to heat the metal to volatilizing point, and then light its vapour, to obtain in the current of air a fine powder of white oxide, which forms the manufactured product ($Zn + O = ZnO$); the equivalent of zinc being 406·6, the oxide of zinc is 506·6, and 100 of zinc theoretically produces 125 of zinc-white."

The factory at Asnières, where we have studied the manufacture of zinc-white, after having previously examined it at Valentin-Coq, stands in front of the village which gives it its name, and to the south of the railway bridge. Although the operations are carried on with activity, the outward appearance presented is that of a factory in holiday times ; its lofty walls permitting none of the bustle in the yards to be visible ; no clanging of engines is heard ; none of its chimneys smoke ; no white powder spreads itself about. This is the greatest praise we can give the manager of the establishment, for the absence of smoke indicates a combustion almost absolute of the coal used ; the absence of white powder proves to all that the *lana philosophica* product is collected, and, consequently, that nothing of value is lost in the operation.

How few factories can boast the same advantages ! When we see the dense black smoke streaming out from so many chimneys, and covering all the country round with coal blacks, we cannot help regretting the good gold pieces that are wasted in the air, to the very great discontent of neighbouring dwellers. At Asnières the necessity of collecting a matter as volatile as oxide of zinc has led to all possible perfection in furnaces and receivers, till finally the smoke itself was mastered. The zinc and coal are landed on the quay before the factory, and deposited in huge covered warehouses, from whence they are taken to the furnace shed, a very lofty hall, from the centre of which rises a chimney, serving two blocks of two furnaces each, and sometimes of four. Each furnace is on the air principle, and contains eight retorts, placed in two rows, up and down, one metre long by forty centimetres broad, and only fifteen high. An iron door corresponds to the opening of each retort, and through this they put the cake of zinc which has to be burnt. A little opening admits the small quantity of air necessary to the oxidation of the metal. Over the four upper retorts there is a truncated cone of strong earthenware, connected by an iron joint to the large cylinder above, in which a square sheet-iron funnel receives the oxide, still hot, which is deposited as it ascends. Already, in issuing from the retort, large flakes of oxide of zinc have fallen into the chamber, arranged between the opening and the iron door ; they are still red, or rather yellow, with incandescence, and are collected under the fire by boxes of sheet-iron, which are changed as they fill up.

Above the ascending cylinder, which receives the hot air charged with oxide of zinc, they have established a system of circulation destined to cool this hot air and the oxide which is suspended in it. This system is composed in the first instance of eight iron cylindrical tubes, of about thirty centimetres diameter, united above by being welded to a point, and spreading out below into funnels in which the oxide accumulates as soon as it is deposited. Each funnel terminates in an opening fitted with iron pipes like the mill-hoppers of a corn-mill, and through these the oxide falls into barrels placed beneath. The cast-iron pipe is bent, and goes through the wall, allowing the air still charged with zinc-white to pass into another system exactly similar, fitted on to the outer wall of the workshop ; there again there are fresh pipes and fresh funnels. This last pipe communicates with a series of separated chambers having an opening sometimes above, sometimes below, and the circulation is finally lost in a chimney which governs the last compartment of the last chamber. During this long course the oxide is almost entirely deposited, and the air, issuing from the chimney, bears away a very trifling portion, which, however, is caught in an iron cap which covers the top of the chimney-pipe. The chambers are about 15 metres high, and their floors are pierced with funnels communicating with the lower stage by means of linen tubes, twisted like the tubes in a corn-mill.

When the workmen on the ground floor wish to empty their linen sacks of the metal, they open them and throw the contents into the barrels. As the zinc-white has cooled in the chambers, they are always able to replace the iron tubes by others in linen, which they can shake so as to detach the oxide.

The collected zinc-white is never equally pure, containing strange oxides and unreduced metallic matter, which give the product a more or less greyish tint. Thus it is classed as " snow white," " white No. 1," " slate-grey," and " stone-grey."

This sorting takes place in an open wooden chest, and experienced workmen mix or separate the different qualities. The zinc-white is put into barrels lined with paper, each barrel being crammed full with the same fixed weight. At Asnières the manufacture demands about 33 per cent. of coal for the weight of metal, and with 100 kilogrammes of zinc 124 kilogrammes of white, of all qualities, is produced, the 24 kilogrammes in excess being derived from the oxygen in the air. We will not enlarge upon the salubrious and humane motives that should induce owners and builders to employ zinc-white instead of white-lead. Living formerly in La Pitié, we were able to see the horrible ravages caused by the lead among the unlucky white-lead workers, and, while acknowledging the praiseworthy efforts made by the manufacturers to preserve their men from this poison, we regret that a general feeling of reprobation has not caused the trade to disappear. We are told, and we hesitate, for the honour of the colour trade, to believe it, that the chief cause of the opposition of colourmen to zinc-white as a substitute is the difficulty of cheating, or at all events the ease with which any fraud can be detected. In a note we give the means of ascertaining the purity of zinc-white and of white-lead.[1]

The first and most ancient employment of zinc, before it was known in the state of a pure metal, was in the manufacture of brass, an alloy of copper which is as widely spread through all industries and domestic economies as the red metal itself. Brass-making consumes very large quantities of zinc, for this metal often supplies one-third part of the different alloys of yellow copper.

At present large quantities of zinc are used in coating iron-wire and iron-plates ;—this is termed galvanization. The galvanized plates have often been tried for roofing, but without satisfactory results : but it is frequently employed for covering sheds. Nails and bolts coated with zinc are in great demand for shipbuilding purposes. As to galvanized wire, all the world knows what considerable quantities are used for gardens, enclosures, and especially for telegraph wires. The firm of Charpentier, at Paris, is the chief producer of this wire ; we also saw something of its manufacture at Fourchambault.

The rolled zinc is used for roofs, gutters, drains, pipes, and decorations for building. For roofing they have tried several systems, the most frequent being that termed *à tasseaux ;* the fluted, which we saw them make at Bray, economizes the cost of framework, and gives a greater strength to the sheets. With the assistance of all manner of stamps the zinc sheets are made to imitate slates, tiles, and even the wooden mouldings that decorate the Swiss houses; very charming effects are thus obtained.

A new application, commenced in 1849, is now in full prosperity : the ornamental stamping of zinc has taken a great hold of public favour recently ; all our contemporary monuments, all the bow-windows and ridges of villas just erected, are

[1] The oxide of zinc is completely soluble in sulphuric acid. To ascertain the purity of oxide of zinc in powder, take a small quantity, and into it pour from fifteen to twenty times its weight in water ; then add a larger part of sulphuric acid. If there is no adulterating matter the oxide of zinc is totally dissolved, and there is no precipitate. If it has been adulterated, the mixture has probably been made with the following substances, insoluble in the sulphuric acid, and which will be precipitated :—

1. Chalk or carbonate of lime, whose presence is betrayed by a precipitate, more or less abundant, in white flakes, deposited very slowly. 2. Sulphate of baryta, the presence of which is indicated by a rapid precipitation towards the bottom of the glass. 3. White clay, which yields a pasty precipitate, collecting itself together very slowly. To test if the paint has been made of pure oxide of zinc, it is enough to scrape away a little quantity, and after calcining it to evaporate the liquid, to submit the cinder thus obtained to the above test. We may be certain that the paint has been made with white lead if, on adding a drop of hydrosulphate of ammonia or sulphide of sodium, the lead immediately turns black. The same effect may again be produced if, as a dryer, we employ fatty oil (oil of litharge), litharge, or acetate of lead.

The purity of the white lead is tested by pouring a small quantity into a glass of water, and slowly adding nitric acid. If the white lead is pure and the water distilled, the white lead will be entirely dissolved, and the water will keep its limpidity ; if, on the contrary, there has been an adulteration, the white lead will form a precipitate. In both cases the employment of ordinary water will produce a milky appearance.

covered with figures and ornaments in zinc chased-work. MM. Grados, Michelet, Bonnet, and Rainer, have made great improvements in this industry, which, indeed, is well worthy of a chapter to itself.

Household utensils, baths, pails, cans, foot-baths, watering-pots, &c. use a considerable amount of this metal; and tin has for these things almost ceased to be employed. Ordinary paint did not adhere well to the zinc, and this inconvenience certainly prevented its exportation, and even its use for household purposes. A special paint has been discovered by M. Heilbron—a paint imitating granite, with which articles are now generally coated. His discovery considerably developed the sale and allowed the exportation of the manufactured goods. Unfortunately, they tell us the inventor is still living in poverty and want.

There are very many other modes of employing rolled zinc. We give a brief enumeration of them :—

Sheathing ships.—Nearly all the fishing-smacks and coasting vessels use zinc sheathing. Copper is only preferred for vessels intended for long voyages.

Packing.—A great consumption for furniture, musical instruments, stuffs, jewellery, fashion goods, and all other objects which are liable to damage by damp. Dried fruits, meal, and ground colours are exported in zinc cases.

Reservoirs for water, vats in breweries, shelves and coolers in refineries, are made of zinc. For engraving, the transfer of lithographs, the printing of music, sheets of zinc are required. One engraver alone, the late M. Gillot, the inventor of paniconography, with his own hand used to engrave more than four hundred square metres every year.

The different applications of electricity demand the use of zinc cylinders, cut in thick sheets of from 4 to 7 millimetres. In this branch there is at present a very large consumption.

The perforated sheets are still very little known in France. In England the industry has already been much developed. Mr. Braby of London, who succeeded Mr. Jack, manufactures these sheets with a very remarkable perforating machine. M. Calard, at Paris, has also undertaken the perforation of zinc in imitation of the English perforation. His goods are well made, but costly.

The use of zinc for bolts and large nails for ships has been abandoned. In spite of the wrapper they put round the body of the metal, the action of the oak of which the ribs are formed corrodes the zinc. On the other hand, French fishing smacks and small coasting vessels are built of wood altogether innocuous to the metal. Nails used in building the ships necessarily followed the fate of the bolts, but the sheathing nails are now generally employed, and with excellent results. Other sizes for nails used in mortar, and for ornaments, roofs, decorations, slating, &c. are still employed, but are as yet upon their trial. Zinc wire, on the contrary, is better appreciated every day; its freedom from rust is a precious advantage for church windows, low enclosures, fences, trellis-work, and for gratings and fasteners for flowers and trees. The rolled zinc serves also for pump-works and for printing-cylinders.

The employment of melted zinc coated with bronze is altogether a Parisian industry. The difference between the cost of zinc and bronze is due, not to the comparative value of the metals, but to the nature of castings, which in zinc are not made in sand, but in metallic moulds, and in this latter case can be reproduced indefinitely in a comparatively limited time.

The low degree of heat at which zinc can be melted is too weak to destroy the metallic moulds. We are then able, almost indefinitely, to reproduce any given model. A zinc object issues from the mould in a carefully and perfectly finished condition, has little need of any hand-touches from the chisel, and is truer and purer in form than the same model in bronze, which very often, through some slipping of the sand model, is defective originally, and afterwards more filed, polished, and, in places, absolutely deformed by the labour of the workman.

The Société de la Vieille Montagne was the first to establish at Paris a foundry of zinc works of art. But as soon as this industry had proved itself successful, the Société was content to supply the new metal to the fine-art workers. About forty individuals carry on this trade at Paris; and in Prussia, Geis, Devaranne, and Korn are equally successful.

M. Ph. Mourey has rendered an essential service to the industry of imitation. His processes of gilding zinc are most excellent, and he has arrived at perfection in making the burnished parts appear like veritable bronze. His discovery has very materially developed the export trade in these articles.

As we have seen, the different applications of the metal which occupies our attention are infinite. New uses of employing it are discovered every day, and although the quantity of old zinc coming back into the trade and re-melted perpetually increases, the Vieille Montagne was perfectly justified in assuring its supplies by purchasing the Swedish mines.[1]

Before finishing this chapter, by an examination into the moral institutions of the Société, we may mention another use to which zinc is put, the employment of this metal in the new bullets; for alas! war can be traced through each and every industry. They manufacture large quantities of zinc bullets for rifled guns. This metal, cheaper than copper, not so soft as lead, is better suited for this purpose than any other. It has a sufficient resistance to preserve the direction, and not enough to injure the grooves of the rifle, which it clogs less than any other metal. The systems and forms of manufacture have been as variable as the form and size of the bullets themselves. The process is thus divided: the sheets or plates of zinc are rolled by private firms, varying in thickness from 6 to 11 millimetres. These sheets are vended to the Government bullet-casting establishments; there they are cut in strips of variable breadth, according to the required size of the bullets. These strips are placed under a punch worked by steam, and the bullets are formed by compression; the zinc, therefore, has necessarily to be of a superior quality, and extremely soft and malleable, to avoid any fissures. The punch at each stroke produces a different number of bullets. This branch of zinc manufacture, very unprofitable and very dangerous to the machinery, and even to the workmen, is but little sought by the firms engaged in the trade.

Including the Swedes, more than 7,000 workpeople are employed by the Société de la Vieille Montagne, and no private company has so well ameliorated the condition of its servants. A benefit fund for the sick and wounded, started in 1838, a provident fund, dating from 1849, assure to the workmen themselves, as well as to their wives and children, an allowance or pension more or less prolonged. Butchers' shops, baking-houses, grocery stores, &c.; schools, singing classes, and many useful amusements, assure the physical and moral welfare of the workman, who, if he is economical and thrifty, can become a proprietor himself, thanks to the kindly arrangements. A council of administration, a staff admirably selected, at the head of which M. Saint-Paul Sinçay is placed as *Directeur-Général*, directs the operations of the Vieille Montagne, which is ever increasing in its prosperous course.

[1] The establishments in Sweden are composed of two lodes or metalliferous zones, situated in almost parallel directions, in the gneiss, and of which the bed consists of felspar and mica. One of these lodes, known at present for its twenty-one different points of attack, is 3,500 metres long, with a depth varying from 4 to 18 metres. This lode is almost entirely composed of blendes, and in certain parts is rich in galena or sulphurate of lead. Three shafts, of about 50 metres deep, are sunk into the lode, and two others are in course of sinking; these will all be connected one with the other by draining galleries, which will throw the water into a little neighbouring valley; this will thoroughly dry the 50 metres, and insure an easy working for many years to come. The second lode, situated some kilometres from the first, has been explored only for 1,800 metres, and is composed only of copper and cobalt. In its deeper parts it is still perfectly unknown, although, having been formerly thoroughly worked on the surface, it promises a very profitable result, when machinery suited to the purpose shall have been established. To work the large lode of blendes, a railway line 12 kilometres in gauge has been laid down, and this is provided with a locomotive and twelve waggons of 10,000 kilos each, connecting the mine to Ammeberg, where the central administration are quartered. A fall of water, varying from 200 to 500 horse-power, according to the season, and having for reservoir a little lake of 6 kilometres in length by 1 kilometre broad, sets in motion the wheels and turbines which work the washing apparatus, and also the crushing cylinders, the grinding mills, the sweeping tables, the tables where the endless cloth is employed, &c. (all of which have elsewhere been described). The factory is organized to triturate 100 tons of ore per day, and to produce 50 tons of concentrated blende, in the rough state containing from 45 to 50 per cent. Ammeberg being situated in a creek of Lake Wettern, is able to receive at its quays vessels of 200 tons burthen, which carry the products by canal to Gothenburg, and thence by sea to Rotterdam, and from this last port by the Rhine to the German factories, and, by the Meuse, to those in Belgium. This year, 1868, 6,000 to 8,000 tons of blende were collected in Sweden; next year the company expect to attain 20,000 tons of prepared blende. At Ammeberg a drying factory has been built to burn the sulphur out of 20,000 tons of blende per annum.

THE INDUSTRIAL DEPARTMENT OF THE LONDON INTERNATIONAL EXHIBITION, 1873.

REPORT ON CLASSES VIII. IX. XII. XIII. AND XIV.

[By our Special Reporters.]

CLASS XIV. brings before us the scientific inventions and new discoveries made within the last ten years or so. We will describe some of the more remarkable ones in the order in which they are quoted in the catalogue.

Professor Bischof, of Glasgow, exhibits samples of spongy iron, which he most warmly recommends for filtering purposes, and the efficacy of which may be ascertained by testing the water which dribbles from a stone filter placed by the side of the purifying agent. The great importance of the question of purifying such quantities of water as are required by our large cities induces us to give a somewhat extended abstract from the lecture which Mr. Bischof delivered a short time ago before the Glasgow Philosophical Society.

At present the only filtering medium extensively used by water companies is sand. Even by the most careful filtration of water through sand only suspended impurities can essentially be removed. The turbidity of water affords a test sufficient to decide the efficiency of such a mechanical filtration. The dissolved impurities are at present, in practical working, beyond the control of any company, unless they can modify their water supply. It is said in practical working, because even by filtration through sand a chemical purification from dissolved impurities may be attained; but this would, according to Dr. Frankland's researches, require such a thickness of the filtering medium, or such an extremely slow filtration, that it is practically impossible.

Mr. B. thinks that the sand, which, after being washed, is used over again for filtering, might be one of the causes of the apparent deterioration of water. The arrangement of these sand filters is well known. At the bottom of the tank constructed for the filter are placed layers of pebble stones, gradually decreasing in size until they come to the size of the coarse, sharp sand which is placed on the top. When water is passed through such a filter nearly all the suspended matter in it is deposited on the very top of the sand, where it gradually chokes the filter. The top sand and dirt is then removed by scraping off about half an inch of the surface. This surface sand or mud is washed with water. It falls from a tank, in which an upward current is produced by water entering at the bottom under pressure, through an inclined sieve, which retains the coarser impurities. From the sieve the sand falls on to an inclined trough, over which the water, which passes through the sieve, runs. The coarser particles of the sand are constantly worked back on the incline of the trough with a spade, while the finer particles and the mud are carried away with the water and run to waste. The sand thus recovered is used over again. The lecturer had analyzed a sample, which had been used over again some twenty times, and another sample of the same quality of sand which had never been used for filtration before.

Both samples, dried at 100° C., were heated to redness. The sample which had not been used lost on heating 1·0 per cent.; and the sand which had been used even less—0·9 per cent. The former, on heating, exhibited the smell of sulphurous acid, but did not turn black; the latter, which had been used and washed, betrayed no smell of sulphurous acid, but turned black. Fifty grains of each sample were then mixed with ¼ litre of Loch Katrine water, and frequently shaken during 24 hours. 100·000 parts of the extract of the sand which had not been used, filtered through paper, gave 0·41 free and 0·48 albuminoid ammonia; the other even less,—0·31 free and 0·36 albuminoid. Nevertheless, considering the facts above alluded to, it may be questioned whether it is satisfactory to rely solely on the filtration of water through sand—at least, if the source from which the water is derived is not above suspicion.

If we bear in mind that London alone requires some 110 million gallons in twenty-four hours, it is not easy to comprehend how a method could be discovered to deal efficiently and practically with such vast quantities. Moreover, considering the difficulties of any chemical purification on an extensive scale, it does not stand quite to reason that the water used for flushing water-closets and the like should be purified equally by the companies with the water used for drinking; and under any circumstances, a chemical purification of the whole bulk of water by water companies would probably result in an *imperfect* purification. In the hands of consumers many plans may be practicable which would be utterly impracticable if applied to the large bulk the water company has to deal with; and the consumer can limit the purification to the comparatively small quantity required for culinary and drinking purposes.

The property of metallic iron of purifying impure water has been known for a long time. It was found, that if ships had to take in foul water, its quality was always materially improved by being kept in iron tanks for a sufficient length of time. Here the rolling of the ship, constantly renewing the contact between the iron and water, accelerates the purifying action, which on land in a state of rest is extremely slow. Dr. Medlock first proposed, in 1857, to employ iron as a purifying medium by suspending, in a tank or reservoir containing the water to be purified by means of iron rods passing across it, iron wire of about $\frac{1}{16}$ of an inch in diameter, loosely packed in bundles or coils, in the proportion of about 1 lb. by weight of wire to every 100 gallons of water. The water was to be left in contact with the iron wire for twenty-four to forty-eight hours. Accepting the latter figure, a simple calculation tells us that for the London supply alone about 1,000 tons of such wire would be required. This enormous quantity would obviously have to be made for the purpose, and would require not unfrequent renewal, consequent on the corrosion of such fine wire. Moreover, the contact offered even by such a quantity appears insufficient, for, after doubling the proportion of iron wire proposed by Medlock, and leaving it in contact with the water to be purified for forty-eight hours, the purifying action was found very trifling. If applied to filtration by water companies, the storing of the water supply for forty-eight hours would here again be another insuperable difficulty.

Dr. Medlock explains the action of iron by its converting the nitrogenous matter and ammonia present in water into nitrous and nitric acid.

The author then proposes, for the purpose of chemically purifying impure water, the so-called spongy iron, or metallic iron, which has been reduced from an oxide without fusion, and which is hence in a loose, spongy state. Spongy iron is made at present from burnt ores which are the residue of Spanish or other pyrites, after extracting their sulphur in the manufacture of soda, and their copper by the wet chlorization process. This is the extraction employed by the Tharsis Copper Company and many other works in the kingdom. At present, owing to the abnormal prices of coal and iron, the price of spongy iron is rather high, but under normal conditions it can be made at from £2 5*s.* to £2 10*s.* per ton.

The spongy iron through which the water to be filtered or purified first passes is contained in a stoneware vessel with a slightly curved bottom. On the top of this bottom there is a perforated bottom, on which the spongy iron rests. An opening in the curved bottom is connected with an earthenware pipe, which passes up the outer side of the vessel to slightly above the level of the spongy iron. Here the pipe communicates with another pipe, which passes from the top of the outside of the spongy iron vessel down to the centre of its closed bottom. The latter pipe is open at the top and bottom, for if it were closed at the top it would act as a syphon and draw off the water from the spongy iron, which should as far as possible always remain covered with water. An alternate exposure to air and water causes the spongy iron to be oxidized, when it loses more or less of its purifying power. A screw tap at the lower end of the latter pipe serves to regulate the flow of the water through the spongy iron.

The spongy iron vessel is placed into the casing of an ordinary stoneware filter with perforated bottom, beneath which there is a reservoir for the filtered water. On the top of the perforated bottom is placed a layer, some 4 in. thick, of finely divided marble or limestone, on to which the water, which contains the iron in solution, flows from the screw tap. By action of the limestone the water is readily freed from iron, and collects in the reservoir ready for use.

The whole filter is covered with a lid as usual.

The layer of spongy iron is about 8 in. thick, preferably 6 in. of a rather coarse and 2 of finer spongy iron on the top, in order that the latter may also act as a mechanical strainer, retaining suspended impurities. If the water contains much suspended matter, the finer spongy iron may from time to time be renewed.

The following analytical results were obtained when filtering water, slightly contaminated with sewage, through Spencer's magnetic carbide filter, Dahlke's silicated carbon filter, and the spongy iron filter. All these filters were well washed with filtered water before collecting the sample, the latter was analyzed immediately, as it was found that the water filtered through the spongy iron filter improves on standing. The latter filter yielded one gallon in forty-five minutes, the other filters,

being of smaller size, one gallon in ninety minutes, as far as this was practicable, owing to their liability to become choked.

Description of Water.	Free Ammonia.		Albuminoid Ammonia.		Organic Carbon.		Organic Nitrogen.		Total comb. Nitrogen.	
	Found [1]	[2]	Found [1]	[2]	Found [1]	[2]	Found [1]	[2]	Found [1]	[2]
Unfiltered water . . .	0·0694	100	0·0225	100	0·2499	100	0·0843	100	0·1414	100
Same filtered through Spencer's filter	0·0602	·87	0·0108	48	0·1045	42	0·0431	51	0·0927	65
Same filtered through Dahlke's filter	0·0389	56	0·0102	45	0·0558	22	0·0764	90	0·1084	76
Same filtered through spongy iron filter	0·0522	75	0·0056	25	0·0216	10	0·0216	26	0·0646	46

[1] In 100,000 parts of water.
[2] This column shows the percentage still contained in the filtered water, the unfiltered water = 100.

Carr and Cunningham show their well-known disintegrating machine.

The machine consists of a series of four strong cylindrical iron cages, of various sizes, formed of bars with open spaces of from three to four inches between them, arranged concentrically one within another, around and parallel with the shafts or axles, and rotated therewith with extreme rapidity in contrary directions to one another by means of an open and a crossed strap, the first and third cages rotating to the right and the second and fourth to the left, so that while there are only two motions in reality, yet from the way in which the cages intersect one another there are relatively four.

The material is thrown in at the central orifice, either by shovels or elevators, and after, the lumps, if very large, are broken by a stationary knife (fixed so that its blade may extend nto the interior of the innermost cage, but never used with very hard materials); they are thrown out by centrifugal force from the first cage at a tangent to its circle, precisely as stones are hurled from a sling, and at a speed equivalent to that at which the beaters of the said cage are rotating (which is usually 50 feet per second). When meeting the beaters of the next cage, moving in an opposite direction, usually at 60 feet per second, a collision ensues similar to that which takes place between a cricket ball and bat; the shock thus produced being compounded from the aggregate speed of the beaters and the speed and weight of the material meeting them. The projectile impetus of the flying material is thereby arrested, and a fresh impulse given it in an opposite direction, to meet the beaters of the third cage travelling the reverse way, and so on in like manner with the fourth one, when, if the material is of a friable and non-fibrous nature, it is shattered by these successive blows into a fine granular state, usually like that of gunpowder, and in less than a second delivered in a radiating shower at a tangent to and from every portion of the periphery (like coruscations of the firework known as the "catherine wheel"), and then arrested in its flight by an external casing of wood or iron, enclosing it, and usually formed like the paddle-box of a steamer.

In this mode of operating it will be observed that the beaters being unarrested by any anvil-like adjunct to absorb their surplus energy, the machine meets with no resistance but that which is justly due to the act of overcoming the cohesive strength of the material it is shattering, which, together with the fact that no friction takes place between the machine and the material, the rare desideratum is thereby attained of having no expenditure of power beyond what is strictly equivalent to the effect produced.

This machine is in a great degree superseding all other pulverizing machines, with an immense improvement in their manufacture, and at a saving in steam power and labour in some individual cases amounting to many hundreds of pounds a year.

The "Diamond Rock-Boring Company" exhibit one of their prospecting machines, designed for boring holes for the purpose of obtaining correct information regarding the strata lying beneath the surface of the earth; holes can be bored to a depth of 1,000 feet and upwards, and perfect sample cores of the strata passed through obtained. These samples are not mere fragments, but continuous solid cylinders, or cores of rock, showing the inclination of the strata, and admitting of accurate analysis. This system of boring, it is said, distances all others in point of time, doing in months what in other ways would take years, and affording reliable evidence (which cannot be otherwise obtained) of the ground passed through.

G. B. Fearnley and Son show a combination of a common kitchen range with a gas-making apparatus, suitable for single buildings, private houses, etc. The whole looks very simple, and the gas produced appears to be at least as good as London gas generally is.

Mr. Neil Greig shows a sanitary trap, which, though simple in its construction, is said to be sufficiently efficacious to prevent the entrance of sewer gases into house pipes.

J. F. Meakin exhibits a model of his self-acting sash-fastener and sash-opener. The first does away with the difficulty attending the putting in of a new line in the case of the prevalent form of window-sash. The second removes the necessity of employing a crook-headed rod for the pulling down the top-sash of large windows.

Blake's patent stone breaker, improved by H. R. Marsden, of Leeds, and exhibited by this firm, has already been fully described in the June number of this year's "Practical Magazine," p. 450.

The "Phosphor-Bronze Company" show a variety of articles made of this new material. It is the usual alloy of copper and tin, with the addition of some phosphorus. Copper and all its alloys have a strong tendency while in fusion to absorb oxygen, which becomes involved in the molten metal. The effect of this intermixture is highly disadvantageous to the bronze founder, producing viscidity and ill-flowing of the metal when cast—its imperfect filling of the mould, and more or less porosity or unsoundness in the casting. The oftener the bronze is melted, as well as the longer it is maintained in fusion, the larger is the amount of imperfection thus produced. Another defect of bronze is the tendency of its two main constituents to segregate in the process of cooling into two or more different alloys, containing different proportions of copper and tin. Now, the larger the amount of oxide contained in the liquid metal the higher must be the temperature to render it sufficiently liquid for casting, and a proportionately longer time is thus given for cooling, and for the tin and copper to segregate in the mould.

The inventors of "phosphor-bronze" prevent these defects, and by a series of prolonged trials have ascertained the properties which phosphorus communicates to the ordinary bronze. Similarly as a small percentage of carbon, in combination with iron, changes the qualities of the latter into those of steel, thus ordinary bronze, by the admixture of phosphorus, changes its qualities and characteristics. The colour becomes warmer, more like that of gold when mixed with copper; the grain or fracture approximates that of steel; the toughness, elasticity, and tensile strength are considerably increased. By varying the quantity of phosphorus the new alloy can be made from a ductile and malleable, but exceedingly tough quality, to such as approach the main qualities of steel.

The Phosphor-Bronze Company exhibit a variety of parts of machinery, viz. bearings, cogwheels, pumps, cylinders, and others; tools, as used by gunpowder mills, on account of their not emitting sparks, viz. scissors, knives, hammers, &c. These tools are very hard, and can with difficulty be touched with the file. The samples of mountings of small arms, revolvers, and cavalry fitments bear the fine rich colour which we mentioned above, and a superior polish; cartridges, which it is stated are in use by the Russian Government, and can be reloaded 120 times over again without repair.

A blast-furnace nozzle of phosphor-bronze is shown cut into halves, exhibiting the core surrounded by the metal on all parts, neither support nor suspension of the core being visible. Nozzles

of this sort are stated to have been in continuous use for several years without repair or change.

We also find phosphor-bronze wire for telegraphic and other purposes, wire-rope, pins and other applications of wire, as also sheets. A table giving an extract of experiments made by the Phosphor-Bronze Company and tested by Mr. Kircaldy shows that this wire is possessed of very great tensile strength and toughness. One test indicates the breaking strain of phosphor-bronze to be 159,000 lbs. per square inch, whilst iron wire only resisted 63,000 lbs. and steel wire 120,000 lbs. per square inch. The wire does not stretch perceptibly when hard drawn, but when annealed it will stretch 46 per cent. before breaking,—whilst iron under similar conditions only stretches 28 per cent., and best copper wire 34 per cent.

Its capacities for conducting electricity are not so great as those of copper wire. According to a table fixed to one of the specimens it is stated to be only 40 per cent. of pure copper. Considering, however, that copper wire is too soft for being suspended alone without the aid of iron or steel wire, whilst phosphor-bronze wire has three times the conductivity of iron wire and an immensely superior tensile strength, thus allowing for longer spans between the telegraph poles, it is probable that phosphor-bronze wire can in many cases be applied with great advantage.

B. C. Tilghman exhibits his apparatus for working the patent sand-blast process already described at page 463, vol. i., and which we again refer to for the purpose of adding a diagram. The main object of the inventor of this process is to engrave ornamental and other devices upon plain and coloured glass, upon stone, and upon metallic surfaces, in an expeditious and economical manner, and with a sharpness which is unattainable by any other means. The invention, which applies chiefly to intaglio and flat relief engraving, is based on the fact that when glass, stone, or metal is subjected to the impact of a blast of sand, or equivalent hard granular substance, the detrition of the surface exposed to its action will be rapidly effected.

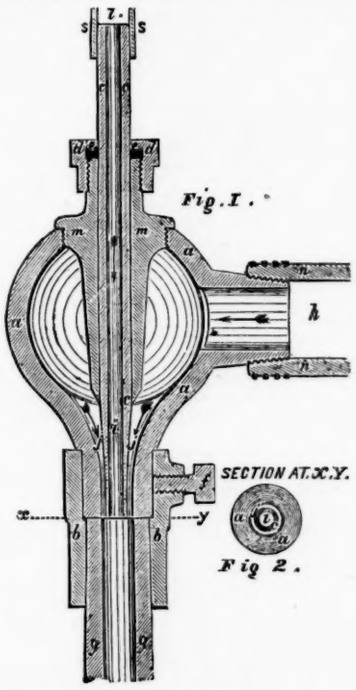
Although the sand-blast acts with energy upon hard or brittle surfaces, it has little or no effect upon elastic and soft substances, such as india-rubber, wax, paper, and lace, and it is upon such substances, therefore, that the patentee relies for protecting those parts of the glass, stone, wood, or metal which are intended to be untouched by the sand-blast. Thus, a piece of lace spread over and cemented to a sheet of glass will so effectually protect the glass when exposed to the sand-blast, that the threads of the network will, after a few seconds' exposure, be imitated on the glass by bright interlacing lines, while the rest of the glass surface will be reduced to a ground or frosted state. The efficacy of the blast depends upon its velocity. The sand may be propelled either by steam, water, or air, but steam is in general preferred where high velocities are required.

When a large quantity of material is to be removed, as in the ornamenting of stone, a steam jet of from 60 to 80 lbs. pressure is used. In this case the stencil is made of iron or rubber; but when a small quantity of material is to be worn away, or the surface merely depolished, as in ornamenting glass, a jet of air of from 1-10 to 1 lb. pressure is preferred. With a low pressure, soft and delicate substances, such as paper designs, lace, leaves, &c., cemented on glass, may be used. With a steam jet using two horse-power of steam at 70 lbs. pressure, and one pint of sand, two cubic inches of granite, four cubic inches of marble, or ten cubic inches of sandstone, may be cut away per minute. It will be obvious that flat or curved surfaces may be alike acted on by this process, the blast being in all cases directed at a right angle to the exposed surface.

The blast process, besides executing ornaments in relief, or intaglio, may be applied for cutting grooves in quarries and tunnels, for dressing stone, for cutting stone in lathes, for cleaning scale from metals, for graining lithographic zinc, and for producing—by the aid of stencils or photographic gelatine—pictures, any variety of design, and even the most delicate line engravings.

In grinding or depolishing glass, the sand and air issue from an aperture forty inches by half an inch. The glass to be ground is placed on a series of rubber bands, which carry it with a uniform speed under the blast. With a pressure of half a pound per square inch, the glass is well depolished when moving six feet per minute. The sand, after being thrown against the glass, falls into a hopper, from which it is carried up by an elevator to a hopper above, and used over again. In cutting stone, the steam and sand issues from a chilled cast-iron tube 7-16th of an inch inside diameter. This chilled cast-iron tube is the only part of the apparatus which is worn away. It lasts from two to three days, and is easily replaced. The jet is held about ten inches above the stone, and, by a mechanical movement, is moved regularly over all parts of the stone. The jet uses one pint of sand per minute. It has been roughly estimated that one-tenth of the sand is reduced to a powder when passed through the steam jet and thrown against any hard material.

The accompanying diagram will help one to understand the working of this interesting apparatus. *a a*, body of steam jet; *c c*, sand-tube, inside diameter 3-16ths of an inch; *g g*, chilled cast-iron tube, chilled inside and outside, inside diameter 7-16ths of an inch, and six inches long, held in position by the coupling, *b b*. The chilled tube and the sand-tube are of iron, the other parts of brass. The steam is conducted from the boiler by a flexible hose (india-rubber), *n n*, entwining the steam jet at *h*, and then passing down through the annular opening, *j c*, fig. 2, into the chilled tube. The steam, in rushing with a velocity of some 1,500 feet per second through this annular opening, causes the air to flow into the sand-tube in the direction of the arrow. The sand is supplied by another flexible tube, *s s*. In engraving



stone, the stone is held about ten inches from the end of the tube, which by a suitable mechanical movement is moved regularly over it.

The Agricultural and General Drying Company show a model of their constructions for the utilization of waste heat and its equable distribution through the substances to be dried, by means of air-ducts, at the same time keeping such substances in constant movement, in order to expose continually fresh surfaces to the action of these air-ducts. These principles admit of adaptation to almost every form of drying machinery, so as to suit the various requirements of different products. When it is remembered that from our factory chimney-shafts, incessant streams of air, having a temperature of from 400° to 650° are now wasted, and when it is further admitted that the loss in most manufacturing establishments is one out of every two tons of coal consumed, it will be seen what a large heating power has hitherto been thrown away.

That this loss may be avoided has been proved at the Thames Cement Works, where two machines constructed on this principle concentrate twenty to twenty-five tons of Portland cement slurry per diem, with very little more fuel than that supplied by the waste heat from two 30 horse-power boilers. It is also there proved that in the erection of new works, chimney-shafts may be dispensed with, and drying machinery constructed in place of them at about the same cost.

By the use of Welsh coal, coke, or smoke-consuming furnaces, the same waste heat may be utilized in breweries and distilleries, for drying grains and spent hops; in granaries for damp corn; in colour, chemical and manure manufactories, for their various products; in sugar plantations for drying megass; in soap works for concentrating leys; by coffee, linseed, Indian corn and other grain exporters, for conditioning their cargoes before shipment, and for many other purposes both at home and abroad.

The drying of brewers' grains may be taken as one example of the saving to be effected by the use of the company's system,

as contrasted with existing processes, for where grains are now dried in the ordinary manner, either on kilns or in steam-heated cylinders, the average cost of fuel alone amounted last year to 12*s.* per ton, and for the ensuing year with coals at present prices will be fully 20*s.*; add to this the cartage 5*s.*, separate rent, salaries, cost of separate management 20*s.*=£2 5*s.* on a product selling at £5 10*s.*, whereas if the operation is carried out on the company's system in the brewery itself, the heat now wasted saves the fuel cost, the cartage charge is avoided, and the cost of separate management and separate rent, &c. is not incurred, whilst the product, by being dried more rapidly and before acetous fermentation has time to act upon it, will be far superior in quality.

Even as a separate business, it has been carried on at the rate of 1,600 tons a year by one house alone, and with a net profit of 10 per cent.; there seems, therefore, good reason for supposing, that when carried out on a system which would save 50 per cent. on the cost, the results must be of a far more remunerative nature.

The drying of wrecked cargoes of grain and of water-damaged salvage from fires will form another branch of the company's operations, by arrangement with those who possess their machines in the various seaport towns.

For processes wherein kiln or hot-plate drying has hitherto been used, the saving in fuel, labour, and space, and improvement in quality of produce, will be self-evident to all scientific and practical men, and it will be one of the chief objects of the company to hasten the adoption of their system, by fitting up the new machinery for maltsters, brewers, and others, and leasing it to them at an annual rent, calculated on its first cost.

S. Danks, of Cincinnati, United States, has a model of his rotatory puddling furnace on exhibition, which is now too well known to require a description.

T. Fletcher, of Warrington, exhibits specimens of gas furnaces, which, without the aid of blast, produce temperatures high enough for the melting of iron.

J. and S. Salter, the well-known boat builders of Oxford, show the model of a boat with sliding seats. The boat used by the Oxford crew in this year's boat race was provided with such seats.

In the list of new inventions we may also notice two recent improvements in stoppering soda-water bottles, although they are ranged in Class XII.

H. Bodd has patented a process of shutting the mouth of the bottle with a glass ball. The ball is inside the neck of the bottle, where it is kept and prevented from dropping into the body of the bottle by a contraction; it is put in in the process of forming the bottle, and, the mouth of the bottle being contracted afterwards, it can never come out. Moulded in the inside of the mouth of the bottle is an annular groove, and in this groove, is fixed an elastic ring. If now the ball is pressed by the gas from within against this ring, the bottle is completely shut. To open the bottle all that is required is a small wooden cap, which, pressed upon the glass ball, causes it to drop, and the liquid can then be poured out. The filling process is equally simple. It consists merely of a rack—hung upon a swivel—which can be attached by a pipe to an ordinary cylinder or globe machine. The bottle is placed on the rack and filled with carbonized water, and the rack inverted, when the ball falls of its own weight into its elastic seating. There is no waste whatever in the process.

Barrett and Eler's patent stoppering rests on a similar principle, with slight differences in the details. In the first instance, the stopper is a wooden plug, and next the india-rubber ring, which serves to tighten the closing, is fixed to one end of the plug, instead of to the bottle itself.

In both these cases there is the certainty that each stoppered bottle must of necessity contain an abundance of gas, and the contents be in good order, inasmuch as the stopper is retained in its place only by the pressure of gas from inside.

The other mechanical processes in connection with the preparation of foods, drinks, etc. shown in working, possess no features of novelty demanding a special description; but they are, nevertheless, of much interest, and form, no doubt, one of the chief attractions of the exhibition.

Artificial stone and stone-preserving preparations are numerously represented at the Exhibition. The Ransome Patent Stone Company stand undoubtedly first in this category.

Mr. Ransome commenced nearly thirty years since his investigations into the nature and properties of stone, with a view to solve the problem of manufacturing an artificial stone which should answer the varied purposes of the productions of nature. He found that, with few exceptions, the hardest and most durable stones were those which contained the largest proportion of silica. After long and patient labours, he produced a stone whose siliceous particles are bound together by a cement of silicate of lime, a mineral substance well known to be of the most indestructible nature. Its composition, mechanically and chemically, is precisely that of the best building stones that are known, such as Cragleith and some varieties of Yorkshire stones, which are able successfully to resist the most trying air and climate on the sea-side and in smoky towns. Its fracture shows perfect homogeneity, so that it is admirably adapted for carving with chisels. It can be moulded into the most delicate forms while in a soft state, and can be surface dressed or finished when hard if desired. Its plasticity during the first process of manufacture enables it to be used with very great economy in all elaborate mouldings and repeated ornamentations, and the perfect truth of its lines and arrises in even very long scantlings, renders it appropriate for all kinds of string courses, cornices and copings.

The process of manufacture is based upon one of the most beautiful of chemical reactions. Flints are first dissolved by means of caustic alkali, under a pressure of from 60 lbs. to 80 lbs. to the square inch, so as to form silicate of soda, a kind of water-glass. This viscous and tenacious substance is then rapidly mixed with a proportion of very fine and sharp siliceous sand in a pug mill, so as to form a soft, plastic mass which can be moulded into any shape that is desired. The soft stone is next immersed in a bath of chloride of calcium solution, which is made to penetrate every pore by means of hydraulic or atmospheric pressure. Whenever this solution comes into contact with the silicate of soda, the two liquids are mutually and instantaneously decomposed, the silica taking possession of the calcium and forming the hard solid silicate of lime, and the soda uniting with the chlorine to form chloride of sodium in a small quantity. Instead, then, of the particles of sand being covered with a thin film of the liquid silicate of soda, they are covered and united together with a film of solid silicate of lime, one of the most indestructible substances known. The small quantity of soluble chloride of sodium, one of the results of decomposition, is then washed out of the stone by a douche of clean water, or by hydraulic pressure, its complete removal being insured by chemical tests. The stone is then dried and is fit for use.

It was found, however, in practice that the process of washing so as completely to remove all trace of the chloride of sodium from large masses of the stone was open to objection—it was both tedious and expensive, especially in localities where there was a difficulty in obtaining a good supply of tolerably pure water at a reasonable cost.

The inventor then conceived the idea of obviating this washing process by producing the insoluble silicate of lime without the formation of the chloride of sodium or other soluble salt, which would require subsequent removal. Step by step this result has at length been arrived at, and the process of manufacture thereby materially simplified, the cost of production reduced, and the application of the material considerably extended. Some years since a siliceous mineral was discovered at the base of the chalk hills in Surrey—especially in the neighbourhood of Farnham—possessing some very peculiar properties, amongst others that of being readily soluble in a solution of caustic soda at a moderately low temperature. Taking advantage of this peculiarity, Mr. Ransome commenced a series of experiments in order to determine if it were not possible, without the use of chloride of calcium, to produce a stone in all respects equal in quality to what had hitherto been done, and in this he has now succeeded.

By this latter process he combines a portion of the Farnham stone, or soluble silica, with a solution of silicate of soda or potash, lime (or substances containing lime), sand, alumina, chalk, or other convenient and suitable materials, which, when intimately mixed, are moulded into the required form as heretofore, and allowed to harden gradually, as silicate of lime is formed by the combination of the ingredients present. The mass then becomes thoroughly indurated and converted into a compact stone, capable of sustaining extraordinary pressure, and increasing in hardness with age.

The chemical actions which effect these results appear to be as under. When the materials are mixed together the silicate of soda is decomposed, the silicic acid being liberated combines with the lime, and forms a compound silicate of lime and alumina, while a portion of soda in a caustic condition is set free. This caustic soda immediately seizes upon the soluble silica (from Farnham), which constitutes one of the ingredients, and thus forms a fresh supply of silicate of soda, which is in its turn decomposed by a further quantity of lime, and so on.

If each decomposition of silicate of soda resulted in the setting free of the whole of the caustic soda, these decomposing processes would go on as long as there was any soluble silica present with which the caustic soda could combine, or until there ceased to be any uncombined lime to decompose the silicate of soda produced, the termination of the action being marked by the presence in the pores of the stone of the excess of caustic

soda in the one case, or of silicate of soda in the other. In reality, however, the whole of the caustic soda does not appear to be set free each time the silicate of soda is decomposed by the lime, there appearing to be formed a compound silicate of lime and soda, whereby a small portion of the latter is fixed at each decomposition. The result is that the caustic soda is gradually fixed, and none remains to be removed by washing or other process.

Having explained the manufacture and chemical composition of the several descriptions of artificial stone herein alluded to, it will be as well in the next place to point out some of the varied purposes for which they are peculiarly adapted. The primary conditions of materials for construction are unquestionably strength and durability—those of a secondary nature being appearance, facility of application to the intended purpose, and economy in use. As regards strength, the value of the artificial stone herein described increases with age. By some experiments which were made for the purpose of testing their possession of this quality, numerous samples were proved, within a month of their manufacture, to be superior to Portland stone. At the age of ten weeks, in stones made by the last described process, the strength, as compared with Portland stone, was found to be as 7,145 lbs. to 2,630 lbs. per square inch, and as compared with Bramley Fall, 7,145 lbs. to 5,120 lbs.; and as regards granite, 7,145 lbs, to 1,200 per square inch. With reference to durability, the artificial stone has been found practically to withstand the atmospheric changes of various climates, having been exposed to the cold of Russia and the heat and rains of India. In general appearance, the stone manufactured by these processes bears such a perfect resemblance to the best description of natural stones as to mislead the most critical observers, whilst the facility of application and its economy in use will have been apparent from the foregoing description.

By means of the last-mentioned process the field has been widely extended for the application of the stone produced thereby, and which for convenience, as distinguishing it from all others, has been termed Apœnite. It is now no difficult task to produce blocks of this material of any form and of any size, the only limit being the means available for handling them upon the spot where they are to be employed. Moreover, the materials which form the bulk of Apœnite are, as a rule, generally to be found in abundance where hydraulic or other important works are being carried on, and for which purposes the new stone is eminently suited.

The applicability of the material to hydraulic works has already been tested successfully at the Hermitage Wharf, where stone caissons, made at the works, have been sunk down to the London clay, a depth of 14 ft. below low-water mark. The work was sunk in sections of about 3 ft. 7 in. deep, which had tongued joints. It is 9 ft. diameter, and the wall 9 in. thick. Its cost is computed by disinterested parties at less than half that of cast-iron. By the adoption of Ransome's caissons for works founded under water, it is evident that a great saving will be effected, as all preliminary and temporary works will be dispensed with.

An artificial stone combining the advantages of Apœnite—one, moreover, which can be so readily moulded into any form and size with but small expense and little or no delay—is necessarily applicable to a great variety of uses. The author will, therefore, only briefly remark upon its applicability for ornamental and decorative purposes.

Besides possessing the several properties which have been described, the Apœnite, when prepared with suitable materials, is capable of receiving the most delicate impressions, and by the incorporation of various metallic oxides, any variety of colour can be imparted to it.

By the use of the native red oxide of iron, manganese, and other mineral substances, artificial marbles or granite of almost every description can be produced. These artificial stones, like their originals, are capable of taking an excellent polish, are extremely hard, and can be readily moulded into the most elaborate forms at a very small cost.

In conclusion, the author submits that, both constructively and ornamentally, Apœnite is eminently fitted to meet the numerous requirements of the engineer and architect, and to subserve many useful and important purposes in the industrial arts.

Ransome's stone has stood the severest experimental tests successfully, and it may now claim to possess extreme resisting power to the attacks of time and weather, as many specimens of it can be referred to which have been used in various buildings in the country since 1862, and others in London since 1866, and which are at the present time still increasing in hardness. The stone is now manufactured in large quantities by licencees and others in America and on the Continent; it has also been made on a considerable scale by the Government in India, and has been extensively used in Bombay, Calcutta and New Zealand; and in England, in the new India Offices, St. Thomas's Hospital, the London Docks, the Brighton Aquarium, the Albert Bridge at Chelsea, numerous churches, and many other public and private buildings.

The works of the Ransome Patent Stone Company are situated on the banks of the Thames, in the district called East Greenwich. They are directly connected with the river by a tramway and a jetty, supplied with a powerful derrick. Almost all the raw material used in the manufactory, and all the finished work sent out, either for home or abroad, are entered or cleared by way of the Thames in the first instance. The works consist of a large covered building, with a dividing wall across the centre, in which there are two openings for the tramways that are laid from one end to the other, and on which the work is conveyed from one point to another as the different processes require.

The establishment manufactures also a special porous mixture for water filters. These filters are slabs of various sizes, which are placed at the bottom of the cistern or vessel the contents of which they are required to filter. A pipe passes from the inside of the filter at its top to above the surface of the water in the cistern. By this the air, displaced as the water percolates into the filter, is allowed to escape. Another pipe from the bottom of the filter, and passing to the outside of the cistern, affords means for drawing off the filtered water as required. They are equal to 100 gallons per day for every square foot of filter surface. If required, the cistern may be fitted with a double set of slabs, with charcoal for purification from noxious gases placed between.

Another special production of the works are the discs for saw sharpening and tool grinding. In addition to the above-described mass they contain silicate of alumina and emery, and their performances in cutting steel are said to be wonderful. Mr. F. J. Bramwell, the eminent civil engineer, speaking on this subject at the Brighton meeting of the British Association, observed that "the superiority of these artificial grinding stones seems to be due to the fact that they are much more uniform than the ordinary stone, and have a sharper cut. The process of manufacture of one of these grindstones, considered in relation to its ultimate use, is very striking. At one moment one sees the shape of a grindstone, it is true, but on touching it with a stick, or even with a finger, one can make holes in it at will. In a few minutes, this same mass, on being struck with a trowel, can scarcely be chipped by it, and very shortly it will be fit to grind the trowel to pieces."

The Ransome Stone Company prepare also a siliceous solution for the protection of stone and brick structures against the corrosive influence of the atmosphere. We quote the following from Mr. Ransome's remarks on the preservation of natural stone:—

"The principal cause of the ruinous decay which is so apparent in the national edifices, churches, mansions, &c. of this country, is generally admitted to be the absorption of water charged with carbonic and sulphurous acid gases, which by their chemical action either decompose the lime or argillaceous matter forming the cementing medium uniting the several siliceous or other particles of which the stone is composed, or mechanically disintegrate those particles by the formation of new salts and compounds within the substance of the stone.

"Many processes have, from time to time, been suggested, and several patents secured, for filling up the pores of the stone, and thus preventing the admission of deleterious agents. These processes have mostly, if not entirely, involved the use of oleaginous or gummy substances or compounds, which, although apparently possessing for a time certain preservative properties, become decomposed themselves on exposure, and consequently require to be renewed; while from the nature of such applications the discoloration produced is highly objectionable.

"If in the place of these temporary and organic processes, a plan can be adopted by which an indestructible mineral can be made to supply the defects of nature, it is evident that a great advantage is at once gained. In Ransome's process this is accomplished, and by the application of two or more separate solutions, which upon coming into contact mutually decompose each other, an insoluble and indestructible silicate of lime is produced in the structure and upon the surface of the stone. This substance is well known to be not only imperishable in itself, but to possess most extraordinary tenacious and cohesive properties, attaching itself to and supporting the several particles of which the stone is composed. It thus renders the softest and most friable of nature's products impervious and enduring, without in the least degree impairing the colour or destroying the characteristic appearance of the stone. Experience has shown that, where once applied, it is impossible to remove it, unless with the substance of the stone itself.

"These processes are not only applicable to buildings and edifices composed of stone, but are also suitable for brick, cement, or stucco, &c., rendering them able to resist the weather

and effectually to exclude damp. When once properly applied, the permanent nature of the products renders repetition unnecessary.

"The Custom-house at Greenock, treated in 1859; the sculpture at St. George's Hall, Liverpool; the Corn Exchange, Chelmsford; Trinity College, Dublin; portions of the Pavilion at Brighton; Cardiff Town Hall; and numerous other public and private buildings in England, India, the colonies, and on the Continent, have been successfully treated with these solutions."

What the air of towns is, we are able to learn from the annual reports of Dr. Angus Smith, the Inspector under the Alkali Act. In one report it is stated that 100 cubic feet of black smoke were found to contain 33 grains of sulphurous acid. In another we find that in London the acidity of rain, calculated as sulphuric acid (anhydride), was rather more than two grains in ten gallons. In Manchester the quantity was nearly six grains in ten gallons, and in Glasgow it was over ten grains. The investigations of Dr. Angus Smith have no reference to the effect of coal-smoke and the contained acids on stone. But he is struck with the great excess of sulphur acids as compared with muriatic acid in the case of the alkali works. He is chiefly surprised at the magnitude of the excess, and he says, "I was prepared for an excess of sulphur acids, since all my recent reports on rain have shown it abundantly. I know, therefore, that the result found so frequently in the rain must be similar in the smoke, which influences the rain; and as the two agree, we must consider it as settled." Dr. Smith leans to the idea that the Alkali Act will ultimately have to be altered, so that instead of prescribing that a certain percentage of gas shall be prevented from escaping, it shall prescribe that no more than a certain amount per cubic foot shall contaminate the immediate vicinity of the chimney. Unmindful of the question we are now discussing, he says: "Coal might be left untouched; that is, we might leave unchecked the amount of sulphur which necessarily arises from the combustion of coal, for the present." But he adds, "The time may come when it shall be considered, and a limit fixed to the amount of sulphur to be allowed; or, in other words, when coal of inferior quality as regards sulphur shall not be allowed to be burnt in closely-inhabited places."

But until that time comes people will have to look out for artificial protection of their houses against these influences. The catalogue shows a fair number of exhibitors of such preservatives.

The "Indestructible Paint Company" show samples of their various compositions. The solutions are equally efficacious whether applied to stone, wood, plaster, cement, or tiles. In all cases it renders the material non-absorbent. No heat is employed in applying the solution, and it may be put on in any season, the only requirement being that of dryness of the surface. If a wall be already damp it must be dried artificially. A very important application of the process is contemplated—namely, the preservation of sculptured marble. It is found quite practicable to give a non-absorbent character to the finest Carrara marble without in the slightest degree affecting its colour. Neither is the degree of glossiness given to the marble at all such as to impair the effect of out-door sculpture. Not only will the marble be thus preserved from decay, but it will be rendered washable, delivering it from those miserable stains which disfigure the finest efforts of the artist. So complete is the protection afforded by the stone solution when applied to marble, that it effectually resists the action of dilute muriatic acid. Even acid of full strength has difficulty in laying hold of the marble. This is the case when the material is but slightly protected. An additional coat or two would doubtless increase the power of resistance. As for any glossiness, it is said that exposure to the weather soon removes that appearance without at all impairing the preservative effect.

The application of this stone solution to marble is as yet somewhat experimental, it having been only recently attempted. It promises results of considerable importance.

Messrs. R. Gay and Co. exhibit two compositions for rendering stone, brick, &c. damp-proof. The one, called the "impenetrable paint," can be produced in any desired colour, and is applied to the surface to be protected with a brush in the ordinary way. It is alike applicable to brick, stone, cement, wood, and iron, which materials obtain a hard, enamelled appearance, which, it is stated, is preserved for years. The solution dries very rapidly, so that three coats may be put on within an hour. Care must be taken not to use it on new brickwork or cement, for lime, while yet in a chemically uncombined state, destroys the waterproofing efficacy of the paint.

The second composition is termed by the inventors the "invisible," because there is no perceptible change in the appearance of the material to which it has been applied. The method of application, which is carried out by special workmen, is as follows: The face of the work to be preserved—whether of stone, brick, cement, or stucco, matters not—is first heated, so that all moisture is driven out and the pores of the material rendered fully absorbent. Whilst the walls are hot, a solution is applied consisting of a patented compound, which is dissolved by heat and payed on with a brush while hot. The air contained in the porous material being rarified by the heat, the solution is induced some distance into the pores beyond what it would be if the natural porosity of the material were the only absorbent medium.

The nature of the solution is such that it is unaffected by atmospheric influences or by changes in temperature. It therefore combines a chemical with a mechanical action, and thus acts not only as a preservative from damp, but arrests decay, should that evil have set in; and in this respect it has a second and very special value. The invisible nature of the solution is very important, inasmuch as it admits of the preservation of objects which would be spoilt by the application of solutions not perfectly colourless and innocuous. Portions of a building, too, may be waterproofed, whilst other parts not requiring to be so treated may be left untouched, without causing any contrast in colour between the parts—or, in fact, any difference in appearance except that the parts treated look a little cleaner than the rest. We have a very absorbent brick by us which has been coated on one side with Messrs. Gay's invisible solution, the other having been left untouched. The coated side repels the water, nor will it enter if allowed to remain on it, whilst the untouched side absorbs water readily. From a number of testimonials before us, we find that this process has been applied very successfully in many bad cases of damp walls. A good proof of the efficacy of this process for waterproofing porous materials is to be found at the Alton paper-mills of Messrs. Spicer. Here a stone vat had been made for holding liquid paper pulp; it was 7 ft. in diameter, and 7 ft. deep. Being of porous stone, the liquid found its way through in all directions, and much loss ensued. Attempts were made to remedy this defect by external applications of paint, but these failed, and Messrs. Gay's process was applied to the interior. Messrs. Spicer write that since that time no moisture has penetrated the stone, although the pressure on the bottom and the sides of the vat must, of course, be very considerable. Besides this, there are revolving arms or stirrers inside the vat which are continually in motion, keeping the pulp agitated. These are strong proofs of the durability and efficiency of the process.

Mr. W. Y. Dent, Royal Arsenal, Woolwich, exhibits a speciality for hardening soft limestone, and rendering it impervious to water. The substance used for this purpose is oxalate of alumina. This compound is very soluble in water, and may be obtained by boiling a solution of oxalic acid with precipitated alumina until no more alumina is dissolved. The proportion of oxalic acid and alumina in the salt thus produced very closely corresponds to that represented by one equivalent of oxalic acid and one equivalent of alumina.

For hardening chalk or soft limestone, a solution having a specific gravity of 1·05 is sufficiently strong for the first application, afterwards it is better to use a solution having a specific gravity of 1·13. It should be applied to stone in dry weather with a brush until the solution is no longer absorbed. The oxalate of alumina is decomposed by the carbonate of lime, an insoluble oxalate of lime and alumina being produced, which fills up the pores of the stone without the formation of any soluble salt likely to give rise to efflorescence.

Mr. J. Murphy, Penzance, shows a collection of various stones before and after their treatment with his preservative, about which he tells us, that it is of organic origin, and that he has employed it with great success for more than thirty years.

We are compelled to omit the reviewing of Class VIII. We propose on a future occasion devoting a special article to silk and its industry.

ASPHALT: ITS IMPORTANCE FOR STREETS IN CITIES AND TOWNS.

By Dr. L. Meyn.

[*Continued from p.* 106.]

BEFORE we proceed to give the rest of Dr. Meyn's pamphlet, it becomes necessary to explain, as hinted in our note on p. 112 of this volume, that, the experience of London being divided, a departure from the usual method of translation is necessary. Certain portions of Dr. Meyn's labours are so obviously marred by insufficient and inaccurate information, that we shall prefer to present some part of what he has done, by

GEMS OF INDUSTRIAL ART.—CABINET FOR OBJECTS OF ART. By Sauvrezy.

putting it into abstract, in a similar way to the reports presented by the chemical editor. It is then proposed to summarize the results of inquiries made independently of Dr. Meyn, down to the present time, amongst our various metropolitan companies. Asphalt may be applied in so many ways, and with such signal advantage, that it is well worth while to supplement the translation of the German pamphlet by this information. It is thought that the entire subject may be then fairly considered as reported upon. Of course suggestions and communications of any valuable or practical nature addressed to the proprietary would receive due consideration, and might subsequently appear in the form of a rider to this article. It is very desirable, in a magazine of this nature, that any remarks intended for the public should be couched in strictly practical terms, and should not be of a purely theoretical character. There are a sufficient number of respectable periodicals at the present day willing to receive suggestions, sometimes even of the crudest kind, and possibly valuable as materials for experiment; but, without disrespect to the great and enthusiastic army of amateurs, it is not to be expected, in our encyclopædical character, that we can undertake to verify matters of pure speculation. With these few words we may be allowed to withdraw, and allow Dr. Meyn to continue and conclude his valuable little treatise.—K. R. H. M.

By means of this company the new method of street paving has found its way to London—a town distinguished in its commercial centre, the City, by a traffic of unequalled extent, and also a locality least likely to endure any material interference with its traffic through street repairs. In order to convince the City authorities of the excellence of this new pavement, the company in May, 1869, laid down, at their own expense, a surface of 485 square yards close to the Exchange in Threadneedle Street. The weather being exceedingly rainy during the time of this operation, the concrete forming the foundation would not bind, and therefore it was necessary to lay a thin coating of mastic beneath the compressed asphalt, so that Threadneedle Street can scarcely be regarded as a proper example. Yet this street, with a traffic of 4,200 vehicles per twenty-four hours, has held together in an admirable manner. The next piece of paving was executed in the ordinary way without a mastic foundation, in October, 1870, in Cheapside and the Poultry—altogether over 20,000 to 30,000 square yards have been completed in the City, and no doubt of the efficiency of the substance can be entertained, the enormous traffic making no impression upon it.[1]

The concrete in London was partly made of lime, and partly of Portland cement, the latter being decidedly preferable. The thickness of the concrete was from six to nine inches, according to the amount of traffic in the various streets. The asphalt rock was afterwards applied in the manner above described, and compressed while warm with hot iron rolls into a completely homogeneous mass without any seams. The thickness of the seam was then from two to two and a-quarter inches, but the traffic has since reduced this by 20 to 25 per cent. The practical result of the application of this material in the two largest cities in Europe, where the busiest traffic exists, is that there is no danger to be apprehended to the traffic from the great smoothness of the surface.

But as complaints have been made by some persons in regard to this, and as any attempt to introduce this pavement into new localities has always been accompanied by a constant recapitulation of all previous accidents—the cry of danger being zealously kept up by the representatives of other systems of paving—it is desirable to confute the objections made against the security of the asphalt pavement for horse traffic. It will be unnecessary in this case to distinguish between the three systems, as the objections, if founded on fact, equally apply to them all, even in cases where, as the following instances will show, the facts are apparently irreconcilable.

At Lyons, where the roadways of asphalt mastic have long been introduced, it happened that in one of these asphalt streets a number of cavalry horses fell. This accident was exceedingly easy of explanation, for it so happened that the asphalt had been laid over a roadway previously macadamized, and very imprudently it had been laid with the same considerable curve, and did not offer a properly even surface. So great a curve is not necessary with asphalt, as the water cannot penetrate, and is decidedly disadvantageous for horses. Now, as the cavalry, riding in open order, was obliged to pass over the steep inclines at the sides of the street, it was impossible to prevent the slipping of the horses, just in the same way as has been seen on a march over arched granite pavement. The military authorities, only thinking of their momentary interests, careless of the funds of the municipality, and inaccessible to argument, caused the whole roadway to be taken up, although slight improvements would have rendered this unnecessary, and thus discredit was cast upon roads of compressed asphalt in certain very influential circles.

It was now attempted to represent that which was a real necessity as a mere Parisian fancy, although it was easy to see from the instance of the roadway at Marseilles between the city and the harbour of Juliette, where there is a very considerable traffic, and where no accidents had occurred, that this unfortunate curvilinear surface at Lyons had been the cause, there existing no such incline at Marseilles, the asphalt causeway having been properly laid down. When the steep curves existing in narrow streets are remembered, and the number of accidents arising on granite pavements so constructed, it will be seen that asphalt pavements actually do away with the possibility of such accidents, rather than produce them.

A very slight incline to each side, or still better, in the author's opinion, a gradient towards one side would be quite sufficient to carry off the rainwater from asphalt roadways. It is rather an error on the part of the engineers than a fault in the material when such accidents as those of Lyons occur.

Of course everything which is said of the sectional view of the roadway is equally applicable to its longitudinal extent, indeed rather more so, as the moment of inertia of the bodies in motion has also to be taken into consideration in a greater proportion. Here also no considerable incline should exist, inasmuch as the smoothness of the asphalt paving increases the impetus of the wheels, and decreases the hold of the horses' feet.

If, therefore, it were a question of the asphalting of public highroads, it would be desirable to decrease the angle of inclination by slopes and dikes, but in the case of streets, where the level is generally known and can only be very slightly affected, the only safe rule would be to abandon the use of compressed asphalt in streets of steep inclines entirely, and use some local material best adapted for the purpose. It is well known that a locomotive ascending at 1:30 has to labour considerably, and a carriage train in the roads of mountainous districts can only ascend with any degree of safety at 1:20. Even this latter ratio is very inexpedient in metropolitan streets, and exceedingly harsh.

But while the usual town draught-horse can overcome the ratio 1:45 upon granite pavement even at a trot, this is impossible on asphalt pavement, and ends in such misfortunes as slipping and other dangers. A rise of 1:60 is that most generally adopted without any danger or detriment, and is nowhere exceeded in Paris, although in London small sections have been laid at 1:57, and at the western end of Broad Street even 1:46, without any accidents having resulted.

There are very few accurately ascertained accidents to carriages and horses upon asphalt streets; but the few of which specific reports exist will be given hereafter. It must be well understood that mere general and unprofessional statements cannot be entertained by proper municipal authorities or qualified engineers. The inventor of the macadamized asphalt ways, M. de Coulaine, *Ingénieur en chef des Ponts et Chaussées*, who broke a lance on his own accord in the *Annales des Ponts et Chaussées*, 1850, then with very great justice drew attention to the fact that, according to the constitution of the human mind, we are not apt to consider over the causes of accidents when they occur as a matter of constant or daily experience, and that we in like manner are very strict, and even unjust, towards new inventions—with which certain disadvantages are sure to be combined, and which are afterwards conquered—in the first instance. It is not unlikely to occur that the blame of an accident, certain to be attributed in the first instance to the rider or driver, or perhaps the horse, should be afterwards assigned to causes existing in the macadamized or paved roadway itself, but first displaying itself on the occasion of such accidents, such as the stumbling or fall of horses upon asphalt causeways.

M. Léon Malo, of Paris, engineer, gives more accurate details of observations made in that city, in the following terms:—

"The number of horses falling in the Rue de Sèze and the Rue Neuve des Capucins had been carefully observed and statistically confirmed during a period of two months. The first of these two streets was paved with broad stones or stretchers of Fontainebleau sandstone, measuring twenty-five centimetres; the second was asphalted. In the former one horse in 1,308 fell, in the latter one in 1,409, the proportion being, therefore, in favour of asphalt."

After the laying down of asphalt in Cheapside, the Board of Works decided upon a similar series of observations, and although the results embodied in the report of the engineer were not made public, it is easy to guess the tenor of the report by

[1] The statistics of Dr. Meyn, it is desirable to state, must be received with extreme caution. It is impossible to say with any degree of accuracy what the average of traffic in certain localities may be. At the same time it points to a necessity for increased vigilance in the persons interested in street traffic; the question of wear and tear being so wide and difficult where an estimation of causes is concerned.—K. R. H. M.

the significant fact that immediately after it was laid before the board a resolution was passed to pave Old Broad Street with asphalt.

Mr. Edwin Chadwick reports in a paper submitted to the Society of Arts, that one of his colleagues in the French Institute who had habitually ridden over an asphalted street in Paris for ten years, expressed himself in highly favourable terms as to the comfort of the pavement; and he added that horses soon accustomed to the new pavement, did not stumble oftener, or perhaps even not so often, as upon the old paving, and when they did the damage to the knees was not so great. The opinion of the General Omnibus Company—by no means partial towards the change in the paving—is that in so far as the number of the horses falling is concerned, there is no difference between granite and asphalt paving. The inspector of ways stated that certainly not more, and perhaps fewer, accidents occurred on asphalt paving. The police, therefore, ultimately considered that there might certainly be a slight impediment to the traffic in slippery weather, but that in fact horses did not fall on asphalt in any greater proportion than they fell upon ordinary street pavement. Such were the results of twenty-seven days' observation. At a subsequent period each office was interrogated in the same manner, and, with the exception of the police authorities, they were unanimous in deciding in favour of the asphalt, in which opinion they were supported by respectable and intelligent inhabitants of the streets under trial.

A very important and trustworthy opinion in this matter is that of Captain Shaw, Superintendent of the Metropolitan Fire Brigade. He states that the heavy London fire-engines traverse the London streets at a great speed for twenty thousand miles every year and according to his experience the transport of these heavy engines is effected with far less liability to accident in the asphalted streets than in the others, without taking into consideration the lighter draught for the horses. 13,000 horses daily pass through Cheapside, and westward of Queen-street 16,000; in all per week, 91,000. During thirty-six days it was observed that 201 horses fell upon the asphalt, being one in 2,323, about half as many as in Paris;—the returns for the stone-paving, however, are not at hand. Yet such facts may be regarded as good evidence of the proportionate value of asphalt as related to stone paving, being, in fact, generally favourable. Indeed, it is to be regarded in such a light, for, as it will shortly be shown that the extreme slippery surface of the asphalt is only exceptional, and that the circumstances may easily be obviated—some of them indeed vanishing of their own accord, when the principle of asphalt becomes more extensively adopted—on the other hand, many an accident occurs by the unaccustomed fright entertained by the horse on a new footing, or the driver, disregarding the change in the pavement of the street, and, in another way, might not draw the reins in such a manner as to relieve the animal, long accustomed, by a particular method of shoeing, to a special gait. The drivers of the heavy fire-engines slightly check their horses when they first touch asphalt, and afterwards resume their former speed. The omnibus-driver does the same. Yet, if a slight drag on the bit occurs, how soon an accident may take place! Such difficulties as these would entirely disappear so soon as an entire district was asphalted in its principal thoroughfares, leading to a greater security against slipping and falling. It is already a very remarkable and satisfactory fact that horses falling on asphalt are very seldom injured, while on stone causeways they are as usually hurt. On a macadamized road, although accidents are very infrequent, a good horse is very often entirely ruined by a single fall. It was remarked above that the circumstances might easily be obviated. The asphalt road does not in all weathers or situations give cause to the falling of a horse, but is rather safer in this respect than any other roadway. This important point did not escape De Coulaine at his time, and no one who has really paid any attention to the subject has omitted to observe it.

During a fall of snow, or in sleighing countries, it follows, as a matter of course, that asphalt roads are not more slippery than stone pavement; indeed, at that very period the very slight convexity of asphalt roads causes horses and carriages to be less liable to accidents. Surface ice is formed by the contact of warm rain with refrigerated ground; it will, therefore, be readily seen that asphalt is not likely to be so subject to the formation of surface ice, being itself of a warm and soft nature, and is heated by every passing ray of sunshine. Thus the surface of asphalt remains unimpeded, while frost attacks the other surfaces, and for the same reason the surface ice will more readily melt and disappear.

But the conditions are changed in ordinary frosty weather, preceded by rain. The macadamized roadway presents a series of rough elevations with small ridges of ice formed in the interstices. On ordinary pavement some more considerable ridges are formed, and the lower stones are covered with ice, tending to cause slipping, whereas the asphalt causeway being already dry at the commencement of the frost, remains without fault.

Considering all the conditions of the slipperiness of the streets produced by frost and snow, as presented by the three systems, there does not seem to be any important distinction to be drawn in favour of or against either of the three systems. It is, however, far different in the summer time. At this period of the year asphalted causeways of all kinds are very superior to any others, because they soften very little, take a very slight impression under heavy loads, and, giving great foothold to the horse's hoofs, render slipping almost an impossibility.[1]

During this time, especially in seasons of great drought, the granite pavement becomes very slippery, yet the asphalt pavement remains normally the same; and it must be borne in mind that the observations about the slipping of horses are usually made in autumn, when there is much dirt about, a period very unfavourable to asphalt as a matter of judgment, but readily remediable in all usual cases.

How destructive granite paving may become to horses during the extremely hot season, it has fallen to the lot of the writer of these lines to observe in a very exceptional manner not easily to be forgotten.

In the midst of high summer time, at burning noontide, the writer saw in the suburbs of Kiel the two first horses of a four-horse team slip upon a granite causeway and fall, and in such a manner that the horses were unable to move a step for nearly an hour without falling again, until strangers came and relieved the drivers,—who were quite incapable of helping themselves, and were crying with anguish,—by unharnessing and leading the horses away. One horse had fallen down, and after having been lifted up again, it leaned anxiously against its companion. In this way both were in a crosswise position as related to the abrupt convexity of the roadway, and fell again in opposite directions, the same circumstances recurring on each occasion of their being assisted to rise.

A similar event might easily take place upon very convex causeways in the case of artillery trains, and might extend itself to the other horses, carrying them down *en masse*. It is hardly possible to estimate the amount of damage likely to accrue under difficulties of the kind. It is quite certain that such things could not take place upon the almost plane surface of asphalted causeways, and although horses falling upon asphalt might not so immediately regain their footing, yet a horse-cloth spread out or a handful of sand will be sufficient to enable them to rise with some degree of security and resume their activity.[2]

The softness of asphalt in summer, its especial advantage over all other roadways as regards riders, horses, and carriages, is maintained in all cases where the temperature of the superficies does not sink below 15° Réaumur, and with the strong effect of insulation upon the black, porous, and very insufficiently conducting surface. Such a temperature is easily attained even on clear cold days. The more dangerous slipperiness of the asphalt takes place only when it has been covered by mud and grease from adjacent streets paved in other ways; it may then be looked upon as no better than a viscous and greasy plane.[3] M. Léon Malo makes the following observations, founded on his great experience:—

"It has been objected to the asphalt causeways that the smoothness of the surface causes the horses when at full speed to fall. The Préfect of the Seine, even in his report, although he regards asphalt as the material destined to save him from macadam and stone-paving, has allowed himself to be terrified by this objection. In reply, it would be sufficient to simply refer him to the observations of De Coulaine, the engineer; but perhaps it would be more convenient to present some explanations founded upon more recent data.

"From a series of most carefully conducted observations it results that the slipping of horses only takes place upon dirty asphalt causeways. On every occasion when a horse passes from one species of pavement to another it evinces a sort of hesitation. This is the more evident on a passage from a hard, uneven pave-

[1] The judicious reader will observe that this is in some measure a geographical or climatic question. Persons of experience deny the last proposition, and the personal observations of the writer are certainly opposed to the statements above made.—K. R. H. M.

[2] The writer of these notes has taken a great deal of care in obtaining practical information from experienced men, in reference to the subdivisions of this subject. It is the opinion of an experienced driver, Mr. R. Bowater, the coachman of Messrs. Sich, the well-known brewers, who employ great numbers of horses, that in all cases a supply of sand should be kept conveniently at hand to asphalted causeways.—K. R. H. M.

[3] It is obvious that extreme cleanliness on the part of street-cleaners would promptly remove this difficulty, and the manure and other refuse would be sufficiently valuable in all cases to warrant the employment of a sufficient boy-brigade.—K. R. H. M.

ment to the smooth and elastic surface of asphalt. But an accident is most to be dreaded when the horse passes from ordinary pavement to asphalt during a period of rainy weather.[1]

"In itself the surface of the asphalt is never muddy, but during foggy weather or mist-rains the mass of dust and horse dung unites and is mixed with the wet, and from accurate observations made by one of the most trustworthy engineers of Paris, it increases in volume five-fold. Thus, a soapy dough is produced which makes the entirely even surface of the asphalt into a slide. It has been proposed to overcome the danger of slipping by artificial roughing of the pavement, and the Préfect of the Seine asks whether this might not be done by a different disposition of the surface or by another method of shoeing horses.[2] But it is clear that ridging the pavement would only lead to a waste of material, for in less than a week the traffic would efface the ridges. Again, any change in the method of shoeing horses, which could only consist in rendering angles acuter, would tend to break the surface of the asphalt, and thus destroy the work.

"Asphalt causeways require, in order to be kept in good condition, a constant compression, for a large amount of traffic only tends to consolidate the mass. Experiments tried at intervals of the six months on the Place Palais Royal have shown that with age the mass increases in toughness and density, although losing something in thickness, owing rather to the compression than to the wear and tear. The surface, therefore, remains unbroken, and is only subjected to the ordinary influence of wheel and hoof. However great the density, there ever remains a certain degree of elasticity, certainly not very great, especially in winter, but sufficiently distinguishable to show that a horse could get a firm foothold. Therefore the only remedy but one to be considered effectual against slipping, is the liberal use of water; an operation not by any means difficult in Paris and other cities favoured with an ample water supply. In places where it is impossible, for local reasons, to employ a liberal washing of the surface, a small quantity of sand may be advantageously spread over the asphalt to prevent the slipping of the horses. This method, however, is only useful for very short periods, and ends in multiplying the mud in an extraordinary ratio. Still, it is easily applicable, as it can be done at any time. De Coulaine had previously referred to these facts. So long, he observes, as the surface is dry, or at least when the mud covering it is liquid, the horses can traverse it at speed without difficulty, particularly if the load is not very heavy. But in the intermediate conditions that is by no means the case, for when the mud begins to dry, it clogs, gains body or coherence, and ends in sticking fast. In this way the tolerably-hard asphalting, at a low temperature, is then covered by a homogeneous layer of fatty mud, impeding the horses to a marked extent. Any other pavement under like circumstances, it is well known, is greasy, and perhaps greasier, in consequence of its being harder; but the cross grooves at any rate afford some foothold to the horses' shoes. In Saumur this difficulty has been met by the application of a thin coating of sand laid on afresh every day, the mud of the preceding day having been previously removed.[3] But where a paved roadway exists in the neighbourhood this becomes unnecessary, as the detritus of material furnishes a natural supply of sand which, carried on by the wheels, is continually renewed; hence asphalt causeways in such situations never become slippery. Observations made in London have afforded exactly similar results. Mr. Haywood, chairman of City Pavement Commissioners, especially insists upon the safety of the traffic depending upon cleanliness. He says that in ordinary dry weather asphalt is not more dangerous than granite pavement, and when the weather is very dry, either in hot or cold weather, it is less slippery than the latter. It does not become greasy when the weather grows somewhat wet, but if a large quantity of mud is allowed to accumulate, it is then certainly more slippery."

The evidence of such distinguished authorities could not more fully agree; it is therefore proved that asphalt paving is quite safe and superior to stone pavement, provided it be kept clean. This is easily done by watering apparatus, and the smooth surface being devoid of joints, brooms and shovels can be used with greater ease than on other roads.

It is certainly always somewhat strange, and perhaps only to be explained by the great breadth of the Berlin streets, that the advantages of the asphalt system have been so sparsely made use of in that city. In 1868 a small piece of asphalt was laid in the Oberwallstrasse, together with the carriage-drive of the Crown Prince's palace, but the inhabitants seemed to take no great interest in the undertaking, while in Paris the municipality was besieged with petitions on all quarters; and in London, after the first experiments in the Poultry and Cheapside, an address from one hundred bankers and merchants asked for the substitution of the new pavement for the old in Old Broad Street, and similar memorials have continually followed since from individuals, and even corporations. The German public should especially be awakened to the advantages of this system of paving. It always bears something of a peculiar aspect to advocate the cause of a single material, as against some or all others, as the defendants are to a great extent unrepresented, and the advocate in a certain sense may be said to be speaking without opposition, and, as it were, from the pulpit.

But if one feels clear that the competing materials can be judged in an unprejudiced manner, when there exists a consciousness that it is only desired to bring about changes for the better, it is readily excusable to set the advantages of the newer substances forth in the best light.

Compressed asphalt possesses two special advantages touching the inhabitants of streets and the convenience of passengers on foot, on horseback or in vehicles. Naturally the first consideration is due to the inhabitants, for it is mainly for them and not for chance passengers that the new material is laid down. For landlords and householders the following points are well worthy of thought:—The first preparation of the new pavement is free from the old adjuncts of street paving. The noise of the trowel and rammer is not to be heard, as in the case of granite paving; nor do great heaps of sand, gravel and paving-stones encumber the space before the door at frequent intervals when the pavement is worn, or the gas or water pipes require examination, as the laying down of asphalt is a noiseless process, without huge mounds of raw materials; and repairs in like manner are swiftly performed, there being only a short time during which the smell of the asphalt is perceptible, and even this is not disagreeable to all persons. But so soon as the asphalt is ready it is perfectly clean and ready for traffic; while the stone pavement, after its completion or repair, is covered with a thick layer of sand, which is blown about by the wind in dry weather, and becomes transformed into mud when rain comes on.

Where the road is macadamized, there is the annoying sound of wheels over the stones to be heard and endured, and the spectacle of a most unmerciful whipping and torturing of horses, in consequence of their loads not being calculated for carriage over the kind of surface; the horse is shaken and perhaps injured by the giving way of the soil when a heavy roller of several hundredweights passes over the stone mass; nor is it uncommon to find gas and water-pipes injured by this crushing weight, which leads to the hardly finished streets being broken up and the work entirely done over again. But upon an asphalt pavement every trace of any repair almost immediately disappears, and even in the hardest winter any necessary work can be executed, while in stone paving and also in macadamization any fault must remain unrepaired until a change to more favourable weather.

Let it be agreed that the periods of road-making and repair are only exceptional, yet even then the constant state of the streets is more favourable for the resident in the case of asphalt pavement than in the others. As to the question of cleanliness it cannot but be admitted that a civilized man would hardly view a muddy road with muddy passengers, horses, and vehicles, with any degree of satisfaction, especially when actual private economical reasons are added to this.

Any one living upon a macadamized road need not be told of the dangers of such a situation. These roads have not inaptly

[1] The writer of these annotations took his stand for three hours at the junction of the asphalt with the stone-paving at St. Paul's Church-yard and Cheapside. No accident occurred during that time, and some six hundred vehicles passed at a busy time of the day. It appeared extremely difficult for drivers of vans and omnibuses to transfer their charges from the stone to the asphalt, but the horses seemed rather relieved when they regained the ordinary pavement. This fact, however, again took place on another occasion in Piccadilly, where the horses in average weather seemed very greatly accelerated in draught-power in passing from stone-pavement to ordinary roadway. It was, however, very painful to observe the evident difficulty under which the horses laboured when "pulled up" on their passage from stone to asphalt. The smooth surface of the asphalt caused a sliding-splay motion in the forefeet in overcoming the impetus of the heavy moving weight behind.—K. R. H. M.

[2] This is a most important suggestion, particularly in our climate, where cab-proprietors during the winter months have to pay a heavy tax, repeated almost every day, by the necessity of roughing the horses, a proceeding which involves loss of time and absolute expense to a very ill-paid body of men. Several horse-shoes have been suggested to prevent this, and important progress has been made towards a solution of the difficulty. Of these patent shoes it is probable, from inquiries of the writer, that Ashton's is the best, especially for horses of heavy draught. A light American shoe was introduced some years since, but it is hardly thought to be suitable for English work.—K. R. H. M.

[3] It ought to be borne in mind that Dr. Meyn is chiefly writing with respect to continental Europe, where the climate does not present the almost incalculable changes of an English season, and also the difficulties of a thronged and never-ending traffic. What, therefore, may be very true for inland places may not be so easily adaptable here.—K. R. H. M.

been called enormous granite-crushing mills. But any one residing on a granite or basalt causeway is well off as compared to another living by a limestone causeway. This limestone road is converted by the least rain into a broad mudway, and the wheels cover everything with filth—trees, houses, windows, especially below the level of the street, and all the passengers. It is often impossible for ladies to cross it, and in all cases persons entering houses are sure to leave a quantity of it upon stairways, floors and carpets. But even this mud is only the better side of the question, for in dry weather the whole mass is transformed into dust, and being forced into the air by carriage traffic or wind, it makes the air unbreathable, enters into the tender, susceptible passages of the lungs, fixes itself on the skin, the hair and the clothes, destroys the flowers and even the leaves of the trees in front gardens, prevents the opening of windows and the entry of fresh air, dirties the window-panes, fastens upon curtains and blinds, pursues the careful housekeeper into the kitchen, larder and cellar, and thus spoils food. This dust in fact, chiefly formed of horse-droppings and sand in a rotten state, is highly prejudicial to health, quite irrespective of its unpleasantness.

Inhabitants of towns have long sought a remedy against this great evil by watering ; but the same amount of water that would suffice to wash an asphalt pavement as clean as a house floor on this kind of pavement is only able to produce a muddy compost, while on a macadamized road it hardly serves to lay the dust.

The city of London annually consumes 13,000,000 cwts. of granite. One sixth of this only being used for street pavements, the rest going for macadamized roads. Therefore this amount is annually ground to dust, and, to the great annoyance of the inhabitants, has on innumerable occasions to be brushed from clothes and furniture, washed from stairways and floors, before it passes into the sewers as filth, often stopping them up, and has then to be carried away by the floods. In addition to this, vast quantities of ships' ballast, consisting of flint stones—the abhorrence of continental road makers—is used in the centre of the metropolis for macadamization.

The annual loss on a macadamized road of the best granite is estimated to be, according to the traffic, from 1 to 4 in., and on Westminster Bridge it is even placed at 5 in. Of some of the abominable limestone roads of some German towns we have no account, but it is not to be doubted that the loss would be greater than that on Westminster Bridge.

If granite pavement suffer only on an average the third or fourth part of such detriment, still there is a continual falling away, the dust being fine and more easily converted into mud. But the pavement of compressed asphalt, on the other hand, is entirely free from these disadvantages, even when the ordinary methods of cleansing applied to other streets are only employed ; for in consequence of the toughness and elasticity of the earth pitch contained in it, every little atom of dust is again combined with the ground by pressure and cannot fly off or be washed away.

When the pavement in the Rue Bergère, which was laid two inches thick in 1854, was taken up in 1869, *i.e.* after seventeen years, in order to relay it in a better manner, it was found to be $1\frac{3}{8}$ in. thick, and wear and tear had reduced it in a minimum ratio, the maximum showing compression by the traffic, as the entire weight of the asphalt by evaporation and wear and tear had only been diminished by five per cent. Similar observations having been made in London and Paris, though perhaps not with such accuracy, on the occasion of repairs, the fact is established that asphalt roads will not cause either dust or mud, and that if the horse-droppings are only promptly removed and the roadway washed every day, an amount of cleanliness will be obtained for the inhabitants increasing with the number of streets asphalted, in consequence of less dirt being brought from other kinds of paving by horses and vehicles. An asphalted street is actually a clear gain in streets where there are a great number of shops filled with costly merchandize, easily damaged by weather or dust, such as delicate dresses, bonnets, and articles of fashion and luxury.

But stone paving in the hearts of towns possesses another disadvantage, affecting mankind in another way, and almost in a greater degree, from the endless rattle and noise of the heavy carriage traffic, and the constant agitation of the subsoil shaking the houses and other buildings. Persons of strong nerve, accustomed to it from their youth, may harden themselves against this evil, but they are never insensible to it, every time they are ill, they become seriously affected by it, and thus they are driven for recovery into the country. But persons of sensitive organization, especially ladies of delicate constitution, of whom there are many in the higher classes of educated society, suffer extremely from this cause, and may have their health entirely destroyed by it. Whoever passes from the country into a crowded city, unaccustomed to its noise, is deprived of his rest by the morning and evening traffic, and the real invalid is often so thoroughly attacked by it, that thick layers of straw have to be laid over the pavement in order that the sick person may not actually be put to death.

Had cities never been familiar with this noise, and been forced to become accustomed to it by circumstances, *i.e.* had asphalt pavement existed for a long time, and it were proposed to introduce stone pavement from motives of economy, would not every street be roused to protest against it? Custom alone has prevented this annoyance from being more than grumbled at. There are actually streets in which it is impossible to pursue the art of music, and any conversation or consultation is rendered difficult, while open windows are almost out of the question. All these annoyances could be done away with at a blow by the introduction of asphalt, the noise of carriage wheels being quite done away with, and the trampling of the horses' hoofs alone to be heard. The inhabitants of Cheapside feel really at ease by being able to converse with their customers with open doors to the shops.

Even the very narrowest streets, where the heaviest traffic exists, and where it has been thought expedient to lay down the hugest blocks of stone, necessitating the construction of very heavy waggons, can now be free, for asphalt, despite its softness, possesses sufficient powers of resistance to carry the weightiest of loads. As an instance of this, it may be mentioned that a granite block of 400 cwts. was transported over the asphalt causeway on a cart without an impression of the wheels being left.

It is therefore for both the most elegant and busiest classes of streets to encourage the system of asphalt paving, especially when it is remembered how fatal to business the breaking up of mercantile streets always is, and when the true economy of the system is generally appreciated, it will then be generally applied in most cities and towns.

It would not be difficult to increase the list of advantages of this new system of roadway for the inhabitants of the streets, but these would only naturally arise out of the principal advantages just named, or from the greater traffic facilities, which, as a matter of course, benefit both the inhabitants and their business or social visitors.

But these facilities of traffic are in fact almost more important, although they may principally, in the first instance, benefit persons not directly contributing to the cost of construction. The foot-passenger finds it most convenient to be able to cross anywhere and at any angle of the roadway, being as clean and comfortable to the feet as the footway. Even in the narrowest streets he enjoys the advantages to be met with only in the broad streets. Nor does he find the footway dirty with the mud at present contributed by the passing carriages. After every shower and every washing the water flows away completely, there being nothing to arrest it, and as the remaining moisture almost immediately evaporates in any weather, carriage-way and footway are almost always dry. Added to these benefits, there is a constant and almost incalculable advantage in the economy of clothing and foot-gear of every description.

The advantages enjoyed by the equestrian on a further development of the system have already been mentioned. He is certainly the least winner, but city traffic also concerns him the least, and he can find other roads to traverse. On the other hand, the benefits to carriage traffic are very great. The wear and tear of carriages and harness by the continual concussion and shaking of streetways is extraordinary. It is hardly to be understood how the mechanism of carriages holds together as long as it does. Although by the introduction of springs on the body of the carriage a great part of the shaking of riders has been overcome ; still, in carts and waggons for heavy transport this has remained the same, and thus deterioration pursues its swift and resistless course. An elegant carriage is only calculated to last about six years in good condition ; after that time it becomes rickety in the joints, and its paint and leather work are destroyed by mud and dust, by washing and cleaning, while the cushions, lining, and carpets suffer a like fate through dust and the necessary consequent brushing. The repairs during six years probably amount to the second-hand price of the carriage, therefore the original cost is entirely lost. On asphalt roadways the duration would be double, and the repairs would not amount to half. But a still greater economy is effected in the matter of horses. The weight of vehicles on asphalt is almost as easily overcome as on a tramway. Thus the dragging and jostling which horses, poor things, have to encounter, is quite obviated, while the waggon can be more heavily laden without hurting the animals in any way, and a great many metropolitan vehicles might be drawn by one horse instead of two ;—the cab-horse would then no longer be an object of pity to every feeling heart.

M. Darcy, whom we have already mentioned, is of opinion that the cost of the renewal of horses and carriages would only

amount to one-half, if in cities like Paris asphalt were substituted for pavement, and this he regards as the minimum of reduction. Malo agrees with him, and estimates an annual saving of more than 8,500,000 francs for Paris alone in the articles of carriages and horses. Although it may be exceedingly difficult to find an absolute numerical expression in such a matter, the figures above stated may be regarded as very important when openly stated by engineers specially entrusted with the superintendence of city paving. As long as the system is not so fully carried out, it will not be actually possible to set down figures of entire trustworthiness; but it is, at any rate, very sure that an intermittent economy in horses and carriages is taking place. The horse—that faithful coadjutor of man—which is so shamefully used, and is unable to complain, must receive some alleviation to its condition while traversing asphalt roadways.

It might seem that this would close the list of advantages accruing from the new system of street causeways, but this is hardly the case, as the metropolitan boards would be benefited in the various spheres of their activity, and the gas and water companies would profit from it in a direct manner.

The shaking of bridge arches and the percolation of water from above is entirely stopped, and therefore the cares to be exercised by the authorities would be greatly lightened. Repairs often stopping half or the whole breadth of streets for a lengthened period, and thus causing interruption in the traffic, which the authorities have to watch over, would be at an end, for asphalt roads are sometimes never in want of repair, and if any be needed it is easily performed, without much trouble and without disturbance.

In consequence of the slighter degree of commotion there are fewer breakages and leakages in water and gas pipes. The loss of water or occasional bursting of pipes, gas leakage and consequent infection of the air, destruction of trees in open spaces, cellar poisoning underground, and explosions, would not be so likely to take place. It would be no longer necessary to have huge trains of waggons to carry away earth and bring up the paving stones, nor would great mud carts continually traverse the streets. Street cleaning, rendered so dear by hand labour, would be confined to occasional washing of the streets, and all complaints respecting insufficient cleaning would be at an end; there would be nothing to say about the clogging of the subterranean waterways by the over-filling to the street traps, and the watering of streets in the summer time would be entirely unnecessary.

Above all things, by this method the city authorities would be able to supply one want to which they have hitherto very slightly ministered, and which yet constitutes one of the most important public requirements—namely, purer air for city centres. If the weather be dry the air is filled with dust, the majority of which is horsedung in a state of decomposition, and acts not only upon man in a troublesome way, but is positively poisonous. The experiments of Professor Tyndall, the pupil and successor of Faraday, prove that all visible atoms of dust in the rooms of London are of organic origin, and other experiments have shown that horsedung is the principal constituent of this mist-cloud of poison. When the weather is wet the miasmata rise from the pavement, and rise still more from the rotting organic mud in the interstices, which no watering can get out without softening the pavement and increasing the evil itself. Worse vapours still arise from the gutters and their joints, the subsoil being charged to a considerable depth with fetid and corrupting matter, as well as from the dark, danky, dirty, sunless passages and courts forming a dismal network of poverty-stricken habitations for the miserable classes in old cities. In these dull spaces, usually embouching upon the narrowest streets, the great number of small dwellings and lodgings causes the continual assembly of crowds of little children, ever dirty and grimy, whose tender little lungs are constantly inhaling the fetid odours of the miasmatic soil, and where they continually are at play with companions dirty as themselves. Here the germs of a whole series of unhealthy and wretched lives develope, and in the centre of the mansions of wealth, pomp, and frenzied luxury, these form a hearth upon which the destroying fire of epidemic diseases continually burns.

These streets and every pathway of them should unquestionably be laid down in compressed asphalt—here every landlord should be compelled by law in the interest of the commonwealth to line the courts and passages with asphalt mastic, and then the most indispensable element of fresh air would be vouchsafed to the children of the labouring classes, on whose strength and activity the luxurious life of the higher classes depends as much as it does upon the hard work of the countryman, who can at least strengthen his constitution under the free air of nature.

If asphalt is conceded to the luxury of the aristocratic quarters of cities, it is unquestionable that the health of the poorer neighbourhoods—badly constructed by the folly of previous administrations—should receive this necessary sacrifice; and in all streets, even before the carriage-way is thought of, the gutters should be asphalted to prevent the accumulation of filthy water and terminate the infection of the subsoil. This has been done in the Rue Hugerie at Bordeaux.

How much expense in clothes and shoes would be saved to the poor inhabitants by this—how much trouble would be spared to the mothers of these poor children—and how full of blessings would be a cheerful temperament resulting from health and cleanliness! This would counteract all those feelings of hatred and jealousy engendered by the heartless and culpable neglect of the wealthy and the careless.

There is only one point of public welfare on which doubt can be raised, and this has indeed received considerable attention on the part of many—it consists in the question of danger from fire. Nor can it be doubted that great risk exists during ordinary fires, and still more when considerable conflagrations take place—that it might be stimulated by the asphalt paving, both by the inflammable nature of the material and the interruption it would cause to traffic under such circumstances.

This view receives great confirmation when it is known, as the author learnt from eye witnesses, that during the great fire at Chicago the walls of the houses and churches belched forth flames, and aided in the burning and ruin of the city, these walls, it being afterwards found, having been built of bituminous limestone, perhaps not containing one-fifth of the bitumen held in the asphalt rock of the pavement. Nor is this fear lessened by the fact that during the siege of Paris, the population, suffering from cold and being short of fuel, broke up the asphalt pavements, and used them for that purpose. But it is answered by the other fact that during the Commune, and when conflagrations were deliberately encouraged, we hear nothing of any fire having been spread by the asphalt pavement itself.

In London, where greater stress is laid upon direct experiment and observation than upon opinion and report, Mr. Haywood made trials on this subject on pavement of Val de Travers and Limmer mastic, by heaping up huge piles of wood, pouring petroleum over them, and setting them on fire. When everything was in full combustion, and the lower ash stratum was red-hot, the stuff was taken off and the asphalt pavement examined. There remained only a few flickering little flames which immediately went out. Captain Shaw, Metropolitan Fire Brigade, who was present at these experiments, expressly declared his opinion that fires would not be spread by asphalt pavement. The many experiments tried of late years with roofing felt have shown that such bituminous substances do not spread fire, but rather act in a contrary manner by damping, whether the fire is above or below the felt. A strong covering of pure asphalt stone has shown the same properties. The Paris Omnibus Company has its fodder lofts immediately over the stables, and in order to protect the fodder from the evaporation of the animals and the atmosphere of the stable, they are covered with a flooring of asphalt. On five different occasions where fire has broken out in their establishments the layer of asphalt has proved itself fireproof, and has at least damped the fire until assistance could be obtained.

Experiments upon a small scale have proved that a wooden flooring covered with asphalt is not affected by any fire lighted upon the latter. The asphalt gives off a volatile bitumen, certainly, which catches fire, and another portion of the bitumen is completely converted into gas and burns as such, but the residue of porous lime, some millimetres thick, and the mixture of coke and lime underneath, both very bad conductors of heat, suffice to defend the lower part of the asphalt from burning, and prevent any remarkable heat or burning of the wood.

On the occasion of a severe fire in the Seyssel asphalt factory, when a cauldron of goudron had burst and run out, and every means of putting out the fire failed, the layer of asphalt on the floor of the workshop directed the flames sideway, and when the wood saturated with the vapour of asphalt was burning and broke together, the covering of asphalt immediately put this enormous fire out. No experiment could be more convincing than this involuntary one. The reason why it happened otherwise in Chicago arose from the circumstance that the walls were vertical, while in most cases the application of asphalt is horizontal, and that would sink down in extinguishing the flames.

After these explanations it will not be necessary to restate that the asphalting of streets is a necessity in great cities, that labour, trouble, wear and tear, and annoyance of many kinds are saved to the inhabitants, and that the sums saved in material and labour far exceed the general cost of putting it down. It is hardly desirable, therefore, to inquire whether the funds of the towns would be affected by it. But, in the nature of things, this is always the first question, because the difficulties of increasing these funds, no matter how wealthy individuals may be, is

GEMS OF INDUSTRIAL ART.—VASE.

MODELLED BY M. CARRIER BELLEUSE. EXECUTED IN IRON BY M. DURENNE.

always intelligible. No answer can be given to that question here.

The very exact investigations instituted by Mr. Haywood, C. E., showed as far as London was concerned—formerly paved wholly with fine regular pavement of small stone of Scotch granite—

1. That the prime cost of the laying down of asphalt is almost equal to that of a granite pavement.
2. That according to contracts as at present made, the annual keeping up of asphalt was slightly more than that of granite.
3. But that after seven to ten years the granite pavement was entirely destroyed, while the asphalt remained as good as ever.
4. That the material of asphalt if taken up retains its commercial value for relaying, or other purpose.

The Paris investigations of Malo have proved the following facts:—

1. That asphalt pavement costs one-third less to put down than block stone causeways.
2. That the maintenance of an asphalt road is three-fourths less than the macadam on the Boulevards.

It will, therefore, not be difficult for any municipality to judge of the general cost of this system of roadmaking, and these statements may lead such bodies to place themselves in communication with the many asphalt companies spread over Europe and America. K. R. H. M.

THE INDUSTRIAL CONDITION OF PRUSSIA.[1]

IN continuation of the consular reports on "The Condition of the Industrial Classes, and the Purchase Power of Money in Foreign Countries" (see pages 226 and 284, vol. i.), we proceed to give Mr. Petre's admirable report on Prussia. This is one of the three specially commended by Earl Granville to the notice of other consuls as a model for the information it affords, and the manner in which the details are given.

BERLIN, *December* 8, 1869.

In reporting, according to the instructions which I have received, upon various points connected with the position of the industrial and artizan classes in Prussia, such as the proportion which they bear to other classes, the description of houses or lodgings which they generally occupy, the nature of their engagements with their employers, the rates of wages which they receive, and other points bearing upon their social condition and organization, it is necessary in the first place that I should give a general sketch of the population of the kingdom, classified according to the various occupations and industries into which it is divided.

The returns of the last census, which was taken on December 3rd, 1867, and some statistical data, for which I am indebted to the courtesy of Dr. Engel, Director of the Statistical Bureau of Berlin, have furnished me with reliable materials for the purpose.

The census of 1867 was the first thoroughly complete one ever taken in Prussia. For the first time all heads of families and householders were called upon to answer the queries submitted by the central office, and when intellectually or physically incapacitated from doing so, their places were filled up by competent persons acting as volunteers, and in the last resort by the police. And as the lists were checked and examined with great care, it is supposed and may fairly be assumed that fewer errors crept into the last census than on any previous occasion. The answers, however, to the queries relating to industrial employments and conditions of labour are known to fall short of a full and perfect statement of the truth. The census fails, therefore, in this respect as an exact record, but no other returns exist than those which it supplies for ascertaining with any minuteness or accuracy the proportions of the various classes into which the population of Prussia is divided.

The total population of Prussia amounted on the 3rd of December, 1867, to 23,970,901, exclusive of Lauenburg, which, though dynastically united with Prussia, is not yet formally incorporated, and has a population of 49,978 persons. The male population amounted to 11,870,433, or 49·52 per cent., and the female to 12,100,508, or 50·48 per cent. The relative per-centage of the sexes had slightly altered since the previous census of 1864, when the female population was only 50·25 per cent., and the male 49·77 per cent. This falling off in the male, as compared with the female population, and consequently in the productive forces of the country, is readily explained by the increase of emigration, which carries off to America so many of the male adults of the population.

Fifty-five per cent. of the males come under the class of heads of families and persons actively employed, and 21·46 per cent. of the females. To every 100 male heads of families and actively employed in some occupation, there are 39·79 females of the same class, with 81·81 male and 145·56 female members of families and dependants. Assuming, therefore, that, taken collectively, the females who are classed as persons actively employed are not in a position to do more than earn their own livelihood, every man of this class in Prussia has upon an average to provide for 3·27 persons, himself included.

These relative conditions vary very considerably in different provinces of the kingdom, but it would be impossible to go deeper into the question without exceeding the scope and limits of a report of this nature.

The proportion of the male population is largest in Westphalia, the Rhenish Province, and Brandenburg, where the great industrial centres are situated, and lowest of all in Silesia, where a portion of the male population emigrates to other provinces in search of employment, in the north-eastern provinces of Prussia (Pomerania, Posen), and in Hesse and Nassau, which furnish the largest annual contingents to emigration. The conscription for the army and the distribution of the troops, which vary in their effects as regards the numbers of the male population in different provinces, are, of course, disturbing elements in the calculation, but they do not affect the main results.

The average proportion to the whole male population of males actively employed or occupied is largest in Brandenburg, Schleswig-Holstein, and Hanover, consequently in those provinces, from the working population (I use the term in its broadest signification) having fewer dependants to provide for, the conditions of labour are most favourable. The least favoured provinces in this respect are Posen, Prussia, and Pomerania, and the taxes yield less in those provinces than in any others. Women who are employed in other than household work are fewer in the Rhenish Provinces, Westphalia, and Saxony, and most numerous in Silesia, Hanover, and Brandenburg. It would be rash, however, to draw any absolute conclusion from these data as to the economical condition of those provinces as compared with others. The long-established customs of the country must also be taken into account with reference to the prevalence of female labour.

Somewhat less than half of the total male and more than half of the female heads of families, &c., having a distinct occupation, more especially in the north-eastern provinces, are engaged in agriculture, consequently the paramount importance of agriculture in most parts of Prussia materially affects the wages and general condition of the artizan classes by its prosperity or depression.

The province of Brandenburg, in which Berlin is situated, and where the value of land and agricultural produce must naturally be enhanced by the proximity of the capital, has, with the exception of the Rhenish Province, the smallest per-centage of agricultural population. This is, of course, explained in some measure by the large population of Berlin, but it is also due to the nature of the soil itself, which, being sandy, requires lighter labour and fewer hands for its cultivation, and admits of earlier harvests. The same may be said of many portions of Pomerania. The landowners in this latter province complain much, however, of scarcity of labour owing to emigration, which has been stimulated by the low rate of agricultural wages and by two successive years of scarcity. The provinces of Schleswig-Holstein and Hanover contain large tracts of meadow and pasture land which require comparatively few agricultural labourers. Saxony has a low average of agricultural population, although the standard of agriculture is higher there than in any other province. It is very probable that, as the census was taken in winter, when agricultural labour in Germany is at a standstill, the floating population was employed on industrial labour elsewhere, and were comprised in some other class.

To turn from the agricultural to the industrial classes of the population, the relative proportion of *employés* and workmen is classed under the two heads of metallurgy and mining industry, and of manufacturing and retail industry or petty trade. With the exception of dividing mining from metallurgy in industry, the census unfortunately grouped together under one head the different branches of manufacturing industry and trade, and there are no reliable materials whatever available for separating the population which is classed collectively under this head into

[1] Report of Mr. Petre, Secretary to her Majesty's Embassy at Berlin, upon the Material and Social Condition of the Artizan and Industrial Classes in Prussia.

its component elements. This separation was made in the census of 1861, but the returns proved to be so fallacious and incomplete that the attempt was not renewed when the late census was taken.

In the provinces of Prussia and Posen local industry is insufficient to meet the comparatively small demand for articles of trade and manufacture required by the population, and yet the industrial classes are by no means in a prosperous condition. They are somewhat better off in Pomerania, where the paucity of the industrial population is owing to the absence of manufactories; and they are still better off in Schleswig-Holstein, where the population, as a rule, is comparatively rich, and the local demand for articles of trade and manufacture consequently greater. Silesia, Westphalia, and the Rhenish Province, where the great iron and coal districts are situated, with the exception of Brandenburg, show the largest number of persons engaged in all branches of industry, and also the highest proportion of workmen to each employer.

As already remarked, the wages of agricultural labour in this country influence to a considerable extent the condition of the working classes generally, and it is exceedingly common for them to exchange one branch of labour for another. Of the agricultural labourers or farm servants, more than half are men and boys. Girls of this class are not so numerous as the women who work as "Tagelöhner," or day labourers. The chief duties of the farm servants in general consist in tending the cattle and flocks, in keeping the buildings and yards clean, sowing the seed, and dairy work. They have to work also in the distilleries and breweries which are commonly attached to large farming establishments, and they are employed generally in the more responsible and important duties of the farm.

At the manor-houses, or gentlemen's seats ("Edelhöfe"), it is usual to employ a large number of these farm servants. The peasant proprietors content themselves generally with one man and a boy, and several maid-servants. Formerly, when labour was more abundant than it is now, the landowners and farmers used to set their faces against their farm servants marrying, but their anxiety now is to induce them not to leave their employment, and with this object they encourage them to marry. The married farm servants are called "Deputaten," or persons receiving an allowance in kind, to distinguish them from the other farm servants, who all take their meals together at the farm. The "Deputaten" receive, in addition to their wages, a certain allowance of corn, potatoes, &c. This primitive practice is, however, gradually giving way to the system of paying full wages in money. Payment in kind, as a rule, is now only made when the farm servants themselves choose to be paid in this manner, as they very often do when the price of corn is sufficiently high to enable them to make a profit out of it.

The want of trusty farm servants is beginning to be universally felt by the landowners and farmers. The causes of this growing change are easily traced. A larger and more varied field of employment has been opened by the development of industry, and by increased facilities of locomotion. A yearning for independence, and for the possession of a home of their own, prevails even among the poorest of these farm servants. The doctrines of socialism, too, which have penetrated, though not to any very great extent, to this class, may have contributed in some degree to alienate them from their employment. The result, however, is that they receive now higher wages and better food than formerly, and their condition is altogether different from what it was. Improvements have been introduced on most of the well-managed properties as regards the way in which the farm servants are lodged, but much still remains to be done in this respect. They generally sleep in the hayloft or in a garret in the cow-house. In all other respects, however, the treatment of farm servants is more considerate than it used to be, and the consciousness of their increased importance, to which this improved treatment may partially be attributed, renders them at the same time far less docile and obedient to their employers than formerly. Those who are in the service of the peasant proprietors, with whom they are more or less on a level in point of culture, are in the habit of taking their meals at the same table with their employers, and differ little from them in their social habits.

It has been observed that, after a series of good harvests, the farm servants, male and female, frequently give notice to quit, in order to work instead for daily wages as "Tagelöhner," which gives them more ready money.

Bad harvests and high prices, on the other hand, have the effect of inducing them to resume permanent employment as farm servants in preference to gaining a more precarious livelihood as independent labourers.

The second class of agricultural labourers, or "Tagelöhner," as they are termed, as distinguished from farm servants, may be divided into two categories: those who contract to work for the landowner or farmer for a certain definite period, ranging from one to three years, and those who have no fixed engagement, but who work for different employers as opportunity offers.

The former class of labourers is very general throughout the eastern provinces of Prussia, but rare in the manufacturing districts. They are usually married, and are bound by their contract to provide, in addition to their own labour, from two to four persons, called "Schaarwerker," to assist them. The system, in short, is a modified form of gangwork. The labourers themselves are bound to work upon the estate from 280 to 300 days, and the "Schaarwerker" (generally the family of the labourer), on the average, 250 days in the year. They are lodged gratis, or at a low rent, in the "Innsthäuser," or farm lodging-houses belonging to the estate, and have a certain portion of land (from $\frac{1}{4}$ to $1\frac{1}{3}$ acres) allowed them, which is manured and cultivated by the proprietor, a shed for goats or pigs, and some small allowances in kind. The wages and conditions of labour for this class of workmen vary too much according to circumstances, even on the same estate, to admit of generalization.

On the whole, their condition is less favourable than that of the farm servants. The class is recruited mostly from amongst those who have made improvident marriages, and are forced by the pressure of narrowed means and increasing families to sell their labour at a low rate. Those amongst them who have small families to provide for, or whose children are of an age or condition to contribute to the support of the family, are, however, decidedly better off than the farm servants, and generally enabled, in the course of a few years, to save a tolerable competency. This is more especially true of those who abstain from the immoderate use of spirits.

The prevailing system of contract work gives the industrious agricultural labourer a fair chance of earning very adequate wages, which he generally supplements by threshing-work during the winter months.

The house accommodation provided for the "Innstleute," or labourers who are lodged by the landed proprietor, is very inferior on most properties, both from a sanitary point of view and also on the score of comfort. Little attention has been paid to it, and the normal standard of comfort and of the sanitary conditions of rural dwellings in general is low. Very little has been done of late years in this direction by the landowners, owing to the heavy charges on estates and to the scarcity of money.

Agricultural labourers who work independently, and are not lodged, like the "Innstleute," by their employers, receive at least 20 per cent. higher wages in money than the latter; and they have this advantage over them, that in harvest-time they can get almost any wages they choose to ask from the landowners and farmers who are short of farm servants and "Innstleute." This is counterbalanced on the other hand by their forced idleness during the winter months, which generally swallows up all their savings, and has altogether a bad influence over their moral conduct. They usually marry in order to have a home of their own, and buy a bit of land on borrowed money to supply them with potatoes and vegetables. Some of them lodge with the peasant proprietors for whom they work, and several families are often crowded together in the same house.

One peculiar feature of agricultural labour in this country is the custom which prevails in several provinces of large bodies of labourers associating together and migrating during the summer months. The system followed is this. An experienced man is deputed to select and report upon some district suitable for the purpose. He then makes a contract for the work which is to be done, and twenty or more labourers, male and female, associate together and undertake harvest or other work for one or more of the large landed proprietors, whose estates are situated sometimes more than 200 miles away from the home of the labourers. When they have finished their work, and received the money which they have contracted for, and which is equally divided amongst them, they return home for the winter. Labouring gangs of this kind migrate annually from the highlands, east of the Vistula, which afford but a scanty subsistence to the population, to the fertile lowlands across that river.

From the fen districts along the Warta, an affluent of the Oder, formerly colonized by Frederick the Great, and now overpopulated, similar bands of labourers travel every summer to the neighbouring provinces. The beetroot sugar manufactories in the neighbourhood of Magdeburg are supplied in this way from the Eichfeld, a sterile district of the Southern Hartz, with the additional labour which they require at a certain period of the year. Similar bodies, called "Hollandsgänger," crop over from Westphalia into the Netherlands; some as agricultural labourers, others as tile-makers; and hundreds of masons migrate annually from Silesia to the north-eastern provinces of Prussia during the summer, to earn money for their support during the winter months.

The economical and social conditions under which the artizan classes ("kleinere Handwerker") live and exercise their industry differ essentially from those of the agricultural labourers, whose position I have briefly described in the preceding paragraphs.

The development of trade and intercourse which marked the beginning of the present century tended to break down the barriers and restrictions which compelled artizans to confine their industry to towns. Large numbers of petty tradesmen or artizans migrated in consequence to the country, and competed successfully with the industry of the towns in supplying the wants of the rural districts, thus partially depriving them of a valuable market which they had hitherto monopolized. One lasting consequence of this change was to raise generally the standard of industrial skill; but its more immediate effect was to ruin many of the small master tradesmen in the towns. A violent agitation in consequence sprang up everywhere against freedom of industry, and led to the enactment of a variety of onerous and restrictive laws and ordinances relating to the exercise of industry, some of which have lasted to the present day, and were only effaced a few months ago from the statute book, when a new "Industrial Code" was enacted by the Federal Parliament for the whole of the North German Confederation. This law has been too short a time in operation for its influence to have been felt, or to warrant any certain estimate of what its effect will be upon the general industry of the country. That it will exercise, *per se*, any very great immediate influence in stimulating the productive industry of North Germany by removing the restrictions which still hampered it, is, perhaps open to doubt, although its value and importance as establishing the principle of the freedom of industry throughout the whole Confederation is obvious. The increase of the population, however, must naturally have a greater influence in this direction, and one less dependent on circumstances, than legislation.

The vastly increased facilities of communication and transport introduced by the railways have had a very important influence here as elsewhere upon the class of handicraftsmen. Small tradesmen and artizans are now no longer able, as formerly, to keep up a stock of goods of their own manufacture for sale. The greater variety and cheapness of goods in the large shops attract customers to the populous towns, and travellers and commission agents scour the country in search of orders, wholesale and retail. For the same reason the annual markets and fairs, where the small tradesman used formerly to find a ready sale for his wares, are either losing their importance or sinking into decay. These circumstances have driven the artizans in many branches of trade, particularly in the large towns, to seek fresh channels for their industry by allying themselves with the manufacturing interest. They confine themselves to the preparation of goods, which are used and bought up by the large manufacturers, and others work at nothing but repairs. Some of them have obtained situations as workmasters or foremen in the large manufactories. The majority, however, still cling to their old course of trade, taking orders and working for customers at such prices as the competition of the large shops and masters carrying on a similar trade to their own enables them to charge. The universal cry amongst this class of small artizans is that their trade is overstocked, and that the labour market is glutted. The real cause, however, of this stagnation of trade, extending also to commerce and manufactures, lies in diminished consumption.

The petty tradesmen or artizans in the small towns and rural districts, in addition to their ordinary business, frequently turn their hands to agriculture, and the possessor of a few acres of land is generally a thriving man in his class of life. Those who are less fortunate contract for employment connected with their industry on the large estates, and earn a little more than the higher farm servants. Where the estates are too small to admit of any permanent engagement of this nature, they move about from one estate to another, and return to do whatever work may have become necessary during their absence. Artizans in the small towns find similar employment in the houses of their customers in return for their board and lodging. At times, when there is no demand whatever for this kind of industry, they are forced to seek employment as ordinary labourers.

Under such changing and precarious conditions of labour, it is not surprising that perhaps half of the families of the artizan class which I have described live in comparative indigence. Fresh meat is an exceptional luxury with many of them, their household economy is of the humblest kind, and indulgence in spirituous drinks even in moderation beyond their means. To their honour, however, be it said, that as a general rule they bear up manfully against hard times, sustained by the consciousness of a higher intelligence than that of the labouring class below them, and also by a pride of craft.

The class of journeyman artizans ("Handwerksgesellen") includes all those persons employed to work for a handicraftsman, who, in accordance with long-established usage, have received a technical education by practically learning their trade for several years under a master, and who have proved, either by executing a prescribed test work, or merely (as in some trades and localities) by having received a certificate from a master, that they have acquired sufficient skill to earn their livelihood in the trade which they have selected. This test or examination is now no longer compulsory by law, but the long-established customs and characteristic usages of trade will in all likelihood survive, and the old rules and formalities prescribed for the admission of journeymen and for the subsequent acquisition of the rank of a master tradesman, be maintained for some time to come.

The practice of travelling, or "wandering," as it is termed, for the purpose of completing his technical education, is still regarded by the German journeyman as an indispensable portion of his training. The young lad, released from his apprenticeship, leaves the house of his master and travels abroad wherever the German language is spoken. He usually, however, visits those towns which have a special reputation for excelling in his own particular branch of trade, and taking up his residence there, endeavours not merely to obtain a livelihood, but also, and more especially, to complete his technical education and to become a skilful workman. For this purpose he gets employment in the workshop of some master and remains there as long as either party choose, subject to the previous notice to quit which may be usual in the trade or in the locality.

If the travelling journeyman fails to find employment in the particular town which he has chosen for his visit, he receives pecuniary aid from the local journeymen's fund to enable him to pursue his journey elsewhere in pursuit of a similar object. The new Industrial Code makes it no longer compulsory upon guilds or trade associations to assist travelling journeymen out of their funds, and as the latter depend entirely for support either upon the employment which they may find, or upon assistance from the funds of their craft, this time-honoured practice of travelling, which, in spite of its practical objects, has a certain colouring of romance about it, will not improbably fall into gradual disuse.

Amongst the large towns which have a special reputation for excelling in particular branches of industry may be mentioned Munich, renowned for its brewers and saddlers, Dresden for its tailors (the Tailors' Academy at Dresden is much frequented by foreigners), Cologne and Munich for their stone-cutters, Barmen (Elberfeld) for its fringe-makers, Berlin and Vienna for their locksmiths, Iserlohn for its bronzers, &c. Leipsic also is considered the best school for teaching the polygraphic art in all its branches.

Some journeymen, who have got the means of doing so and have a talent for acquiring foreign languages, widen their experience by travelling beyond the limits of the Fatherland. Numbers of enterprising journeymen leave every year to visit the watchmaking establishments of the Jura, the machine manufactories and lockmaking works of England, the arms and gun factories of Liége, and the industrial establishments of Lyons, Brussels, and, above all, Paris. Many of them remain some years or permanently settle in these places, and, true to their German habits of thrift and industry, generally thrive. They are, as a rule, however, the *élite* and most intelligent of the class of journeymen, and their success, therefore, is less to be wondered at. Whilst the German artizan is to be found in nearly every country in the world, Germans following other avocations seldom, with the exception of commercial people and men of letters, leave their country except to cross the ocean. The travelled journeyman (and the same is true in a lesser degree of those who have limited their wanderings to Germany) returns to his own country from abroad not only possessing the advantages of improved knowledge and technical skill, but with his mind and general ideas expanded by a knowledge of the world beyond the narrow limits of his own home. In fact, he returns a much more enlightened man in every way than he was when he set out.

This practice of travelling is exclusively confined to journeymen of the German race. The Lithuanians and the Wends hardly ever occupy themselves with any other industry than agriculture, and Polish journeymen are not numerous, except in the shoemaking trade, which seems to be the special branch of industry most patronized by them. In the Polish province of Prussia this class of travelling journeymen is unknown, and there is a total want in the country of good models from abroad.

Another institution connected with travelling journeymen deserves a casual mention, as a relic of the past. For centuries, certain inns,—"Herbergen" as they are called,—have been

specially set apart for the purpose of lodging and entertaining journeymen on their travels. These are used also as houses of meeting, or labour marts, to which masters of the various trades of the locality in want of workmen are in the habit of repairing. In former days these inns enjoyed certain privileges which now no longer exist, and in some of the more populous towns particular trades have their own special "Herbergen." This ancient institution of industrial "caravanseries" is, however, gradually dying out for many reasons. The inadequate sleeping accommodation which they provide for the travelling journeymen who frequent them, and the temptations and opportunities which they offer for excessive expenditure, and even for drunkenness and gambling, have tended to bring them into disrepute. The Protestant and Catholic communities both took the matter in hand, and have established separate inns for journeymen of their respective religions, and these are conducted by respectable managers or lessees. They are also used as inquiry offices for masters and workmen, and for the meetings either of the Protestant Young Men's Societies or of the Associated Catholic Journeymen. Inquiry offices for workmen are established in several towns independently of any religious connection, and chiefly for the purpose of assisting workmen in procuring suitable lodgings, but many of them have been closed for want of support.

With some few rare exceptions, neither the state, nor the communes, nor the chambers of commerce have ever actively concerned themselves in any way with the labour question with reference to supply and demand. Journeymen artizans in seeking openings for their labour can resort to the means, defective and insufficient as they may be, which I have described, but no such institutions exist for the purpose of assisting factory operations, independent workmen, or agricultural labourers in procuring work.

The journeyman usually earns almost as much as a petty master, and if he is unmarried he is probably better off than his employer. In bad times, however, he runs the risk of loss of employment, and in the ordinary course of things exhausts his stock of savings. If he is fortunate enough to get employment in some large manufactory, and succeeds in recommending himself to the owner by the higher standard of industrial knowledge and skill which the journeyman in general acquires, his condition is much improved and his future less precarious. For even when the trade is at its worst, and production reduced to its narrowest limits, it is the interest of the millowners not to let men of this stamp slip through their fingers.

Of the class of artizan apprentices little need be said. The youth of fifteen, when he has finished his schooling, selects his trade, and binds himself by covenant to a master for board, lodging, and instruction, and is taught the mysteries of the craft, generally free of cost, either by the master himself or by a journeyman deputed for the purpose. He is bound generally for three years, but in case of ill-treatment by the master, he is at once set free. One common abuse connected with the treatment of apprentices is that the masters frequently employ them in doing their household work, which deprives them of the leisure time to which they are entitled, and keeps them from regular attendance at the schools which are established for completing the non-technical education of young artizans. Employers, too, often avail themselves of apprentice labour—which costs them nothing but the board and lodging of the apprentice—to an extent which journeymen look upon as detrimental to their interests. On several occasions the journeymen, by combining against the masters, and even by invoking legislative aid, have attempted to limit the number of apprentices. Not long ago the owners of the large printing offices in Germany admitted the justice of this demand on the part of the journeymen, and agreed in consequence to adopt certain fixed rules on the subject. The Industrial Code, however, recognizes no such restrictions upon the reception of apprentices.

I will now proceed to describe the general condition of factory operatives in Prussia. I have alluded above to the favourable position of those employed in factory labour who are recruited from the class of journeymen. The ordinary factory operative, although inferior in versatility and professional skill to the journeyman, is also materially well off. In respect to the sanitary state of the workrooms at the factories, public opinion rather than the law enforces the observance of certain rules and conditions in the interest of the health of the operatives, and in the large towns the police are armed with special powers in this respect. I believe, however, that the arrangements fall very far short at least of our English standard of what is necessary.

As a rule the factory operatives are fairly and properly treated by their employers. The hours of labour, however, are longer than they should be, and although the manufacturers in some of the industrial centres (in Gladbach amongst others) have agreed not to work their machinery more than twelve hours a day, they form an exception to the rule, which only legislative interference can materially alter.

Wages are for the most part sufficient to support single persons in comfort, and if they are at all thrifty, they can save, and frequently do so, but the wages are insufficient to support a wife and children independently of what the latter earn themselves. The manufacturing population is pre-eminently deficient in the resolution which distinguishes other industrial classes in this country, to strive to work their way up, even in spite of adverse circumstances, to comparative independence. The monotony of their daily labour seems to produce in them an inordinate longing for enjoyment, in the gratification of which they spend a considerable portion of their earnings, and weaken their physical powers by dissipation.

Improvident and reckless marriages are very common amongst them, and end almost invariably in their decay and ruin. One result of their mode of life is, that as a class they are more discontented than any other with their lot, and lean more to socialism and subversive doctrines. I must in justice add that there are very numerous exceptions to that which I have described, as a general rule, amongst them. Where the intelligent millowner has taken care to provide for the physical and moral well-being of the workmen in his employ, as is the case, for instance, in many of the extensive ironworks of Westphalia and the Rhine Province, the majority of the manufacturing population live in a prosperous condition, and look down with compassionate pity upon the less favoured agricultural labourer. In other places educational societies ("Bildungsvereine"), presided over by men of high consideration and intellectual attainments, exercise a very beneficial influence in tending to introduce amongst the operatives a taste for intellectual entertainments and pleasures. The engine builders at Berlin, a very numerous class of operatives employed in M. Borsig's manufactories, have a high reputation as an exemplary and thoroughly efficient body of workmen on excellent terms with their employer.

Fatherly relations, in the sense of a kindly intimacy between employers and employed, are very rare and exceptional in this part of Germany. There is something, even when both parties are best disposed towards each other, in the North German character, opposed to such relations. An admission that their mutual interests require a due reciprocity of good offices between them and their employers is the utmost to be expected from the working classes in this country. At the present day, a majority of the factory operatives refuse even to admit this. All that they consent to recognize is the necessity of earning the means of subsistence.

Although the general standard of living is more or less uniform amongst all those who work at the mills and manufactories, except that in the western provinces of the monarchy, the operatives demand and obtain much higher wages than in the eastern provinces, the same cannot be said of those who work for the mill-owners at their own homes. Omitting some few manufactures of local importance, such as the tailoring establishments at Berlin, the lockmakers and smiths at Wuppsenthal, near Elberfeld, and to the agate cutters of the former Duchy of Nassau, I select the weaving trade as the most important.

By far the greatest portion of textiles are manufactured by the weavers at their own homes, with the assistance of the members of their families, or of journeymen, for large commercial houses and manufacturers. The latter supply the materials, and buy up the textiles at certain prices previously fixed upon.

The large silk manufactories on the left bank of the Rhine, for example, are able to give employment, with the necessary materials, to the handloom-weavers for several months at a time. A direct communication being established between the manufacturer and the weaver, the services of a middleman are not required. The weaver, as soon as he has finished his work, takes it to the manufacturer, and brings back with him a fresh supply of material. This class of weavers is tolerably well off. They are in possession of good looms, and are generally considered as sure to earn a decent livelihood. In times of great stagnation of trade, they have suffered, of course, severely, in common with others, but they have generally recovered themselves with comparative ease.

In the mountainous district of Middle Silesia, where fifty years ago the linen industry was in a most flourishing condition (until the rise of Irish competition and the closing of the Spanish market, through the foreign policy of Frederick William III., in refusing to acknowledge Queen Isabella of Spain, gave it a death-blow from which it has never recovered), the condition of the weavers is far less prosperous than those to whom I alluded above. Most of them, when the linen industry declined, turned their hands to cotton weaving; but as they could not afford to purchase the new looms, they had to work on credit, and being completely at the mercy of the large manufacturing and com-

mercial establishments by whom they were employed, were obliged to accept the lowest possible wages.

Attempts have been made, apparently with small success, to draft these Silesian handloom-weavers into other branches of industry and other occupations.

Of the more important groups which constitute the working-classes of Prussia, these weavers, numbering about 30,000 or more, are undoubtedly the poorest, the worst fed, and from their weak physical constitutions, which does not prevent them, however, from having large families, the least capable of raising themselves unassisted above their present condition. Some change for the better has been effected of late by the erection of large spinning and weaving factories, fitted with first-rate machinery, on the skirts of the mountains, attracted there no doubt by the cheapness and abundance of labour.

With respect to the employment of female labour in manufactories, owing to the rapid increase of population and the great development of industry, women are employed now to a much larger extent than formerly in the factories. More than a fifth of the whole number of factory operatives are females, and considering that the greater portion of them are members of families, and that they receive comparatively good wages, they are decidedly well off in an economical point of view. Their moral condition, owing to the male and female operatives working indiscriminately together at the mills, is from all accounts much less favourable. The reports from the various provinces describe them as inordinately fond of pleasure and given to dissipation, adding that large numbers of them live a dissolute life, and have to bring up illegitimate children. Many of the mill-owners take particular care to keep the workrooms of the sexes separate; but in some branches of manufacture this precautionary measure is impossible. The proprietors of the smaller class of manufactories show little inclination to incur expense by introducing the changes in the working of their establishments which the adoption of such a measure would render necessary.

The regular employment of children under twelve years of age in factories, mines, iron-works, or stamping mills is forbidden by the Industrial Law of the 6th April, 1869. Youths under sixteen are not permitted to work in any of the establishments above named for more than ten hours a day, and they must be allowed half-an-hour's interval of rest both in the morning and in the afternoon, and a full hour at noon, with liberty for exercise in the open air at each time. In addition to this the law provides that due attention shall be paid to their health and schooling, and obliges factory owners to furnish periodically exact lists of all the juvenile operatives in their employment. Still greater restrictions upon the employment of juvenile labour were imposed by the law of the 16th May, 1853, although some concessions were made at the time to the masters. For the present state of the law as regards the employment of children in factories, the hours of labour, &c., the reader of this report is referred to the Industrial Code of 1869, a textual translation of which is annexed to it.

Amongst the working classes in Prussia the miners and iron-workers hold an exceptional position, inasmuch as their welfare and interests are attended to by the Government officials who are appointed to superintend all the mines, iron works, and salt works in the kingdom. This class of the labouring population is animated by an honourable *esprit de corps* dating from the earliest times, and forming a singular exception to the egotistical tendencies prevalent amongst the working classes of the present day. The great importance naturally attached to the conservation of so able and staunch a race of workmen as these miners and iron-workers has induced both the state and the private owners of the larger works to provide suitable dwellings for them, and to make such general provision for their comfort and well-being as to make their lot an enviable one in comparison with many of their fellow-labourers. They seldom, however, succeed in amassing any considerable savings, and some of them emigrate from time to time to other countries where the mining industry is on a smaller scale than here.

The miners and iron-workers of Upper Silesia are almost exclusively Poles. They contrast unfavourably with the German workmen in their addiction to debauchery and dissipation, so much so that in many of the works where they are employed measures have been adopted for paying the weekly wages due to them to their wives, to prevent them from squandering their earnings instead of supporting their families. To what extent this system prevails I am unable to say; but, however legitimate its object may be, it seems to be rather too great an interference with individual rights to admit of very wide application.

Foremen of works in factories, managers of printing offices, foremen of mines, and other such like headmen and overseers employed in industrial establishments, are considered more in the light of *employés* than of workmen, and in disputes between the masters and the men, they generally side with the former. This intermediate class is certainly one of importance and influence in the social and economical questions which are constantly arising between the representatives of capital and labour, and yet it is by no means treated with the consideration which it deserves. The reason is that there is always an abundance of educated men in this country who are only too glad to be able to obtain employment of this kind. The salaries paid to persons of this class are just sufficient to provide them with the means of living in tolerable comfort, but they are considerably lower than what are paid to a similar class in every other country.

Porters, loaders, packers, and such like labourers who are employed to do heavy work of all kinds, whether for commercial and industrial establishments, or in sea-ports and inland towns, or in connection with any branch of public traffic and transport, generally earn good and even high wages in this country, as the great physical strength required for this sort of labour is rare enough to prevent the labour market from being overstocked. These people soon save a sufficient sum of money to enable them to set up an independent business as carriers, small shopkeepers, &c. Examples of this kind are numberless, but, at the same time, drunkenness is the bane and ruin of many of them.

Day-labourers ("Tagelöhner") in the towns, men who work first for one person and then for another, are generally well off if they are known to a tolerably large circle of employers, as the wages paid to this class of labourers in towns are high. If the labourer is known only to a few employers he is very often left without work, and falls into pauperism. The "Tagelöhner" are employed both in town and country in cleaning the streets, in making roads and railways, felling timber, sawing wood, &c.

Workwomen in the towns, including all those not employed in coarse manual labour, such as sempstresses, milliners, embroiderers, and the like, are divided into two classes, differing from each other very much both as regards their material and social condition. Those who, from not being able to obtain private employment, are obliged to work for the large shops, clothing establishments, fringe makers, &c., are miserably paid, owing to the demand for this species of employment being so much in excess of what is required to meet the wants of the public, in spite of the constant changes in the fashions. The bulk of workwomen of this class, unless they are very clever at work, and have some means of their own wherewith to buy a sewing-machine, take to prostitution. Workwomen of the other class, on the other hand, who succeed in getting a good private connection, go out to work in private houses, or work at home, and are able to earn a comfortable subsistence, and to save money. As a general rule, their moral conduct contrasts favourably with that of their less fortunate fellow-workwomen.

Having given a general sketch of the condition and leading characteristics of the various groups into which the industrial classes of this country are divided, I will now proceed to sketch in detail some of the most important points, a knowledge of which is essential in forming a correct estimate of their material condition. This detailed information relates to the following subjects:—

1. Their mode of living, and what is required for the annual support of a working man's family, including lodging, firing, and clothing.
2. The description of houses and lodgings generally occupied by them.
3. The school system, with reference to the industrial classes; and workmen's associations and their social movements.
4. The rates of wages which they receive.

I.—Annual Cost of Living of a Working Man and his Family.

The Statistical Department in Berlin, in the year 1860, obtained, through the agency of the provincial authorities, certain official statistical returns relating to these subjects, which afford materials from which I have been enabled to extract the subjoined minute information, showing what is annually required for the support of the families of the working classes in various provinces of the kingdom.

The calculations are made on a presumed average of four, five, and six persons to each family, whereas it has been previously stated that every male workman personally engaged in labour is, on the average, charged with the maintenance of only three to four persons, himself included. To explain this apparent contradiction, I must state that more than half of the whole number of male labourers personally employed are single men, and consequently the average, in that respect, of three to four dependents to each workman was a correct one.

By examining and comparing the returns of the rates of wages which immediately follow the returns showing what is annually

required for the support of a working man and his family, a correct estimate may be formed of the sufficiency or insufficiency of the workman's earnings to meet the necessary cost of living, and whether any surplus remains for requirements of a less pressing nature, or is available for a savings fund. Also to what extent the wives or children, if they are of an age to work, are able to contribute to the support of the family; and lastly, how far the poor rates or private benevolence must come to their aid.

The following returns deal for the most part with the years 1860 to 1864, before the aggrandizement of the Prussian monarchy, but their value as statistical data is not, or but little, affected by this.

ANNUAL SUM REQUIRED TO SUPPORT A WORKING MAN AND HIS FAMILY.

Provinces, Districts, &c.	Number of Persons in Family.	Subsistence.	Lodging.	Firing.	Clothes.	Articles of Household use, and Tools.	Taxes and School Money.	Total.
		£ s. £ s.	£ s. £ s.	£ s. £ s.	£ s. £ s.	£ s. £ s.	£ s. £ s.	£ s. £ s.
I.—Province of Prussia (average of 17 returns):								
a. Administrative District of Gumbinnen—								
Rural districts	4 to 5	9 0 to 12 0	1 10 ...	0 18 ...	2 17 to 4 10	0 9 to 1 10	0 6 ...	15 0 to 20 14
Towns	4 5	15 0 ...	1 16 ...	1 16 ...	3 0 ...	0 18 ...	0 9 ...	22 19 ...
b. Administrative District of Königsberg—								
Rural districts	5	6 0 15 0	0 18 2 14	0 12 1 16	2 2 4 10	0 9 1 10	0 6 to 0 18	10 7 26 8
Small towns	5	... ...	... ...	... ...	... ...	... ...	... ...	27 0 ...
Town of Memel	...	... ...	... ...	... ...	... ...	... ...	... ...	22 10 25 10
Town of Königsberg	...	27 0 ...	4 10 ...	1 4 ...	2 8 ...	0 12 ...	0 6 ...	36 0 ...
c. Administrative District of Dantzig—								
Rural districts	...	12 18 15 0	1 4 1 16	... ...	3 0 4 10	0 18 ...	0 6 ...	18 6 22 10
d. Administrative District of Marienwerder—								
Rural districts	...	... ...	... ...	... ...	... ...	... ...	... ...	15 0 ...
Towns	...	9 0 10 16	1 16 ...	1 4 ...	2 2 2 5	... ...	0 9 0 12	14 11 16 13
II.—Province of Posen (average of 15 returns):								
a. Administrative District of Bromberg—								
Rural districts	...	7 10 ...	1 16 ...	1 16 ...	6 0 ...	1 4 ...	0 6 ...	18 12 ...
b. Administrative District of Posen—								
Rural districts and small towns	5	6 0 16 10	0 15 2 5	0 12 3 0	1 4 4 10	0 3 1 19	0 4 0 15	8 18 28 19
III.—Province of Silesia (average of 31 returns):								
a. Administrative District of Leignitz—								
Rural districts	3 to 5	7 10 13 1	0 18 2 5	0 18 2 2	0 12 3 9	0 3 1 10	0 6 0 15	10 7 23 2
Small towns	...	... ...	... ...	... ...	... ...	... ...	... ...	18 0 24 0
Town of Görlitz	4 to 5	15 0 16 16	4 16 5 5	... ...	2 14 3 3	0 12 ...	0 18 ...	24 0 26 14
b. Administrative District of Breslau—								
Rural districts	4 5	7 10 14 8	0 15 2 5	0 12 2 2	0 15 4 10	0 3 1 4	0 3 0 18	9 18 25 7
Manufacturing districts	...	12 0 16 10	2 2 3 0	0 18 1 7	3 0 6 0	0 9 3 0	0 6 0 12	18 15 30 9
Small towns	4	7 10 18 0	0 1 3 15	0 15 2 5	1 4 6 0	0 3 3 15	0 3 0 15	10 13 30 6
c. Administrative District of Appeln—								
Rural districts	5	11 8 1 10	0 18 1 7	0 9 1 4	1 16 2 14	0 12 ...	0 6 ...	15 9 19 3
IV.—Province of Pomerania (average of 7 returns):								
a. Administrative District of Köslin—								
Rural districts and small towns	5 to 6	7 10 15 0	1 16 2 11	1 4 1 16	1 10 3 0	0 3 0 18	0 9 0 12	12 12 23 17
b. Administrative District of Stettin—								
Rural districts and small towns	4 5	7 10 10 10	0 18 3 0	0 18 1 16	1 19 ...	0 6 ...	0 15 ...	12 6 18 6
V.—Province of Brandenburg (average of 6 returns:)								
a. Administrative District of Potsdam -								
Rural districts and small towns	5 6	12 0 18 0	0 9 1 16	0 9 1 10	1 10 7 10	0 9 0 15	0 12 0 18	15 9 30 9
b. Administrative District of Frankfort—								
Rural districts and small towns	4 5	10 10 21 0	1 10 2 5	0 12 2 8	2 5 3 0	0 15 1 10	0 12 ...	16 4 30 15
VI. Province of Saxony (average of 18 returns):								
a. Administrative District of Magdeburg—								
Rural districts and small towns	5 6	10 10 17 11	1 10 2 14	0 15 1 16	2 5 7 10	0 6 1 10	0 6 0 15	15 12 31 16
Town of Oschersleben	5	15 12 ...	2 5 3 15	1 10 ...	7 10 ...	0 18 ...	0 15 ...	28 10 30 0
Town of Magdeburg	5	18 0 ...	3 15 4 10	1 10 ..	4 10 ...	0 15 ...	0 15 ...	30 0 ...
b. Administrative District of Merseburg—								
Rural districts and small towns	4 to 6	9 0 24 6	1 4 2 14	1 4 3 0	1 16 4 19	0 12 1 10	0 6 1 4	14 2 37 13
c. Administrative District of Erfurt—								
Rural districts, &c.	4 6	9 0 13 10	0 15 1 11	0 18 2 2	1 4 3 6	0 6 1 10	0 3 0 12	12 6 23 11
Town of Nordhausen	...	14 2 16 10	2 14 3 6	1 7 2 5	1 10 3 0	0 3 0 9	0 9 0 15	20 5 26 5
VII.—Province of Westphalia (average of 16 returns):								
a. Administrative District of Minden—								
Rural districts and small towns	5 to 6	10 10 13 10	1 10 1 16	0 15 1 16	2 5 3 0	0 9 1 1	0 9 0 15	15 18 21 18
Bielefeld and Paderborn	...	... ...	... ...	... ...	... ...	... ...	... ...	18 0 27 0
b. Administrative District of Münster								
Rural districts and small towns	5 7	7 10 18 0	1 4 4 10	1 1 3 0	1 10 4 19	0 15 1 16	0 7 0 15	12 7 33 0
Town of Münster	...	12 15 13 10	3 0 3 15	0 15 ...	2 5 3 0	0 15 ...	0 15 ...	20 5 22 10
c. Administrative District of Arnsberg—								
Circle and town of Lippstadt	5	12 12 14 2	1 16 2 14	1 16 2 5	3 15 4 10	0 9 ...	0 18 1 4	21 6 25 4
VIII.—Rhenish Provinces (33 returns):								
a. Administrative District of Düsseldorf—								
Circle of Essen. Northern part	5	26 5 ...	3 18 ...	1 16 ...	4 10 ...	0 15 ...	0 15 ...	37 19 ...
,, Southern part	5	22 13 ...	3 0 ...	1 16 ...	4 10 ...	0 15 ...	0 15 ...	33 9 ...
Solingen. Manufacturing part	...	... ...	... ...	... ...	... ...	... ...	... ...	32 0 36 0
,, other parts	...	... ...	... ...	... ...	... ...	... ...	... ...	24 0 28 10
Mettman. Manufacturing districts	5	18 15 ...	3 0 ...	3 0 ...	3 15 ...	0 15 ...	0 15 ...	30 0 ...
Düsseldorf	5	... ...	... ...	... ...	... ...	... ...	... ...	22 10 30 0
Towns in Rees district	5	18 0 ...	2 8 3 0	0 18 ...	2 11 ...	0 7 ...	0 15 ...	24 19 25 11
Country districts of ditto	5	13 10 ...	1 10 ...	0 18 ...	2 2 ...	0 7 ...	0 9 ...	18 16 ...
Town of Reuss. Labourers	4	10 10 12 0	1 16 2 14	0 18 1 4	3 3 4 4	0 3 0 6	0 9 0 15	16 19 21 3
,, Mechanics	4	13 10 15 0	3 0 5 8	1 4 1 10	6 0 7 16	0 9 0 12	1 4 1 10	25 7 31 16
Rural districts	4 to 5	10 10 12 0	1 10 2 5	0 18 1 4	1 10 3 3	0 6 0 15	0 9 0 15	15 3 20 2
b. Administrative District of Cologne—								
Rural districts of Cologne	5	22 10 ...	3 0 ...	1 16 ...	3 0 ...	0 15 ...	0 9 ...	31 10 ...
Town of Deutz	5	27 0 ...	4 10 ...	1 16 ...	3 0 ...	... ...	0 9 ...	36 15 ...
,, of Cologne	6	39 12 ...	6 15 ...	2 14 ...	9 6 ...	0 18 ...	2 5 ...	61 10 ...
,, of Bonn	5	21 0 ...	4 10 ...	1 16 ...	2 5 ...	... ...	0 9 ...	30 0 ...
Rural districts and small towns	5 to 6	15 0 19 10	2 5 3 0	1 10 2 11	2 5 4 10	0 6 0 15	0 6 1 4	21 12 31 10
c. Administrative District of Aix-la-Chapelle—								
Rural districts and small towns	4 5	10 10 16 1	1 10 3 15	0 18 1 10	1 16 3 6	0 6 0 9	0 6 0 15	15 6 25 16
In the manufacturing district of Eupen	6	... ...	2 14 3 0	... ...	... ...	... ...	... ...	36 0 ...
d. Administrative District of Coblenz—								
Rural districts and small towns	5 to 6	18 0 19 10	2 5 ...	1 16 3 18	2 8 4 10	0 15 1 1	1 4 1 10	26 8 32 14
e. Administrative District of Treves—								
Rural districts and small towns	4 6	10 10 19 10	1 16 3 15	1 4 2 5	2 5 7 1	0 9 2 5	0 6 2 2	16 10 36 18
Town of Treves	5	16 10 ...	4 4 ...	3 0 ...	6 0 ...	1 4 ...	0 12 ...	31 10 ...

To show the bases upon which the foregoing calculations are framed, and at the same time to give a general idea of the style of living prevalent amongst the working classes, more particularly in the country districts, I subjoin a few details extracted from the reports of the provincial authorities showing the nature and quantities of the food required in different parts of

the country for their annual sustenance, with the prices in English currency.

Province of Posen.

Administrative Circle of Adelnau.—An artizan's family, consisting of two or three children, requires annually for food 22½ bushels of rye, value £3 15*s.* ; 70 bushels of potatoes at £3 15*s.*; cabbages, 15*s.* ; millet, peas, grits, wheaten flour, salt, &c., £10 10*s.* ; meat and butter, £8 5*s.* : total £27.

Province of Pomerania.

Circle of Oels.—An artizan's family requires annually 1⅞ bushels of wheat, 7*s.* 6*d.* ; 22½ bushels of rye at £3 ; 6 bushels of barley at 12*s.* ; 3 bushels of peas at 8*s.* ; 60 bushels of potatoes, £1 10*s.* ; 30 lbs. of butter, 18*s.* ; milk, 18*s.* ; beer and brandy, 18*s.* ; meat, £1 10*s.* ; salt, 13*s.* 6*d.* ; food for a goat and a pig, 15*s.* : total £11 10*s.*

Circle of Neurode.—On the assumption that the food of the working classes in this circle consists chiefly in bread, potatoes, peas, millet, grits, milk, butter-milk, &c., the cost of an adult's food daily is from 4½*d.* to 4⅔*d.* The cost of living for a working man with a family of three or four children, including rent and fuel, may be set down at the lowest at 9½*d.* a day, or something under £15 a year.

Circle of Pless.—A day labourer's family ("Tagelöhner") requires annually 15 bushels of rye at £2 5*s.* ; 144 bushels of potatoes at £5 15*s.* 2*d.* ; cabbages, 15*s.* ; milk, 18*s.* ; butter, £1 4*s.* ; salt, £1 4*s.* : total, £13 4*s.* 2*d.*

The families of iron-workers and factory operatives require additional meat, milk, and butter, to the amount of about £3 in value.

Province of Prussia.

Circle of Stendel.—A working man's family consisting of five persons requires annually 27 bushels of rye, £5 8*s.* ; 72 bushels of potatoes, £2 8*s.* ; a pig, £2 8*s.* ; food for two goats, 12*s.* ; 50 lbs. of butter, £1 16*s.* : total £12 12*s.*

Circle of Wernigerode.—A family consisting of five persons consumes annually 27 bushels of rye, £5 8*s.* ; 72 bushels of potatoes, £4 1*s.* ; a pig, £3 ; 52 lbs. of butter, £2 12*s.* ; food for two goats, 12*s.*: total, £15 13*s.*

Province of Westphalia.

Circle of Rechlinghausen.—Bread, £6 ; vegetables, potatoes, and butter, £3 15*s.* ; meat, £3 15*s.*; total, £13 10*s.*

Circle of Koesfeld.—Families of working men in towns consisting of five persons, require for their annual consumption, supposing them to have a garden, black bread, £2 14*s.* ; white bread, 6*s.* ; meat, £1 16*s.* ; milk, 6*s.* ; coffee, 6*s.* ; chicory, 6*s.* ; salt and groceries, 3*s.* ; butter, 18*s.* ; potatoes and vegetables, 15*s.* : total, £7 10*s.*

Circle of Lippstedt.—A working man's family residing in the town requires annually in food, 75 bushels of potatoes, £5 10*s.* ; 27 bushels of bread corn, £5 17*s* ; meat and butter, £2 14*s.* ; total, £14 1*s.* In the country the total is about £12 13*s.*

Rhenish Province.

Circle of Essen.—The prices of many articles of food and necessaries of life are higher in the northern than in the southern part of the circle. The prices of food annually required for a working-man's family in the northern part of the circle amount to £26 5*s.* 0½*d.* ; and in the southern part of the circle to £21 16*s.* 6*d.*

Circle of Geilenkirchen.—A family of five persons, including three children under 14, requires for its consumption annually, 1,725 lbs. of bread, costing £7 12*s.* ; butter, £2 8*s.* 7*d.* ; coffee or its substitute, 18*s.* ; 36 bushels of potatoes, £2 14*s.* ; suet, oil, vinegar, and salt, £1 16*s.* 5*d.* ; rent of cabbage garden, 12*s.*: total, £16 1*s.*

Circle of Gummersbach.—A family of five persons requires for its annual consumption 1,800 lbs. of potatoes, at £3 15*s.* ; 1,200 lbs. of bread, £4 19*s.* ; 300 lbs. of flour (chiefly oatmeal), £2 14*s.* ; 26 lbs. of butter, £1 1*s.* ; 10 lbs. of bacon, 6*s.*; 180 quarts of milk, £1 4*s.*; coffee and salt, £1 1*s.* ; vegetables, 15*s.* ; meat (on Sundays and holidays), £1 10*s.* : total, £17 5*s.*

Circle of Jülich.—The principal food of the working classes consists of potatoes, bread, and coffee. Meat is generally eaten only on holidays.

Circle of Montjoie.—Similar to the foregoing. The daily consumption per head is reckoned at 1 lb. of rye-bread, 2 lbs. of potatoes, 1 oz. of meat, ½ oz. of salt, ⅛ oz. of coffee.

Circle of Ohrweiler.—A working man's family consumes annually 2,190 lbs. of bread, £9 18*s.* ; 2,920 lbs. of potatoes, £3 12*s.* ; meat, suet, salt, butter, flour, £3 12*s.* ; coffee and chicory, 18*s.*: total, £18.

Circles of Wittlich and Bernkassel.—The working classes live almost entirely on bread, potatoes, vegetables, grease, salt, and coffee.

The foregoing particulars relating to the various articles of food required by the families of the working classes in different localities are founded more or less upon conjecture, and in some instances probably the calculations are not strictly accurate, but they vary little from each other, and when they do vary the difference is clearly traceable to the special circumstances of the locality, such as its general state of prosperity, the price of provisions, and rates of wages. The returns, therefore, upon the whole, may be taken as approximatively true.

II.—Dwellings of the Working Classes.

It is almost impossible to describe in general terms the character of the houses occupied by the working classes in Prussia, varying so widely as they do in different localities. What may be true of the houses in one place is altogether inapplicable to those of another, and even of others in the same locality or in the neighbourhood. The subjoined account, although necessarily imperfect, will serve to give an idea of the general class of habitations in which the labouring population lives.

In the large towns the artizan classes live almost exclusively in lodgings, and it is rarely that the independent artizan or small tradesman lives in a house of his own, whereas in the country and in the small towns the latter is more frequently the rule than the exception. The houses inhabited by the rural artizans, labourers, hand-loom weavers, &c., both as regards their structure and living arrangements, are generally of the poorest kind, especially in the eastern provinces. Labourers, factory operatives, miners, &c., are frequently obliged, even in the country, to live in lodgings or else in buildings expressly constructed for working men by the large landed proprietors in the eastern provinces, and by the mill-owners and proprietors of mines and ironworks, and companies, in the western provinces. In many districts in the west, joint-stock building companies and co-operative building societies have been established with the object of supplying the want of proper dwellings in particular localities ; they purchase land with the subscribed capital and erect dwellings suitable for working men and their families, and then let them at a moderate rent, frequently with the option of purchase by the payment of a certain annual sum for interest and sinking fund in addition to the rent.

The provincial authorities of the eight provinces of which Prussia was composed previous to the late war have furnished the following particulars relating to the dwellings of the working classes in their several departments. They date back as far as 1864, but they are the latest which exist.

Province of Prussia.

1. *Circle of Memel.*—The dwellings of the workmen in the rural districts are poor and inadequate in the extreme. The houses are of one story, built of mud, and some even of grass ; the windows are nailed up, and never opened. They contain, in general, one dwelling-room and a sleeping-room, frequently unfloored.

2. *Circle of Königsberg.*—The houses of the working classes are usually built for two families, and houses lately have been built for four families of labourers. In these, each family has a dwelling-room, with a stove for cooking, one bedroom and a loft, and either a stable or pig-sty.

3. *Town of Königsberg.*—The Building Board insists on light and space being properly attended to in the erection of new dwelling-houses.

4. *Circle of Gerdauen.*—In the small country towns several families often live together in one room. Of late years, however, there has been much improvement both in the structure of the houses and in the internal arrangements.

5. *Circle of Seidenberg.*—In the towns several families frequently live together in small, dark, and damp rooms. The want of dwellings for the poorer classes is very much felt.

Province of Posen.

Circle of Sampter.—In consequence of the garrison, rents have risen immensely. Labourers' families have to pay annually from £3 to £3 15*s.* for the rent of a wretched room.

Province of Silesia.

1. *Circle of Görlitz.*—Rents have risen in the town of Görlitz at the rate of 10 per cent. every five years for the last twenty years.

2. *Circle of Leignitz.*—In many of the rural communes, the houses are thatched, of one storey, and with small windows, admitting little light and air. The interiors low, dark and contracted, with close and bad air.

3. *Circle of Balkenhain.*—The weavers' houses in the country usually contain from two to three living-rooms, and one or two

bedrooms. One room is only large enough to hold from one to three looms, and but little furniture. The rooms are barely sufficiently high to stand upright in, and the windows are not more than 2 ft. square.

4. *Circle of Oels.*—A great improvement has taken place in the dwelling-houses as regards health and comfort; but rents are rising.

5. *Circle of Reichenbach.*—The houses in the more important manufacturing districts are overcrowded with weavers, and rents are high. The number of houses does not increase in proportion to the growth of the population.

6. *Circle of Münsterberg.*—One room is seldom inhabited by more than one family. A living and bedroom in the country costs 6*s.* to £1 4*s.* a year, and in the manufacturing district as much as £3 12*s.* In the town of Münsterberg, a single room costs from 18*s.* to £1 10*s.* annually.

7. *Circle of Pless.*—Several labourers' families (from ten to fifteen persons) frequently live in one room. There is no pretension to comfort or cleanliness. In the country, the annual cost of a room is from 18*s.* to £2 5*s.*

Province of Brandenburg.

Circle of Templin.—A marked improvement has taken place in the dwelling-houses, particularly as regards space. In the town of Lychen, a working man's family pays £2 14*s.*, in Templin £3 12*s.*, and in Zeldenich £4 10*s.* per annum house rent.

Province of Saxony.

1. *Circle of Staumberg.*—With the exception of the village of Altenburg, where the inhabitants are crowded together more than is consistent with health, the space in the dwelling-houses for families is double what it was forty years ago.

2. *Circle of Schlesingen.*—In the populous parts of the mountainous district, several families frequently live together in one room.

Province of Westphalia.

1. *Circle of Minden.*—There is a great dearth of dwelling-houses in the country, and some of the communes have erected, in consequence, what are called "Communal-houses," or "houses for the poor." In the town of Minden itself this want is most severely felt, and a working man's family has to pay from £6 to £7 10*s.* for house rent annually.

2. *Circle of Paderborn.*—There is a deficiency of dwelling-houses, particularly for the lower classes. They are forced to live in confined spaces at high rents.

3. *Circle of Ahaus.*—The dwellings of the labouring classes are confined within the smallest possible limits; they generally consist of a kitchen, a living-room, place for a few beds, a cellar or a garret, and a stall for a cow, goat, or pig. The rooms are small and low, and frequently damp.

4. *Circle of Koesfeld.*—The dwelling-house of a working man's family consists usually of a kitchen, living-room, one or two sleeping-rooms, and a cellar or loft, with a shed for a goat. The rooms are small and low. House rent in the towns is from £1 10*s.* to £2 8*s.* annually.

Rhenish Province.

1. *Circle of Essen.*—The workmen in the coal-mines form a colony in the vicinity of the mines, consisting of as many as 100 houses. House rent for the working classes in the towns is from £3 to £3 15*s.*, and in the country from £2 5*s.* to £3 annually. The families of working men are often pinched for room, in consequence of their taking in other workmen as boarders. The latter sleep in the garret, but otherwise live with the family in one or two rooms.

2. *Circle of Daun.*—The houses of the day-labourers ("Tagelöhner") are mostly bad, small, and so densely crowded, that, without great attention to ventilation and cleanliness, sickness is sure to prevail.

3. *Circle of Ottweiler.*—In the mining colonies lately established here the houses of the miners are neat and cheerful. The three royal coal-mines of Heinitz have three large sleeping-houses belonging to them to accommodate 800 men. The Rheden mine has two of these, for the accommodation of 400 men. The miners pay 1*s.* 6*d.* a month, for which they have a bed and towels and the use of half a press. To enable miners to settle in the neighbourhood, the Miners' Union ("Knappschaftsverein") has purchased 1,350 acres of land for founding a mining colony. It sells at cost price, or leases at a moderate rent, one-sixth of an acre of land to any one who will build a house upon it, and one-sixth of an acre on the same terms for a garden. Money for building purposes is also advanced, at 4 per cent. interest, to be deducted from the wages, with a present of from £22 10*s.* to £30 as a premium for building. From the year 1842 to 1861, within the district of the Saarbruck Miners' Union, 1,499 miners' houses were built in this way, for which £58,159 was advanced, and £22,626 given in premiums.

The following particulars relating to the city of Berlin are extracted from the report accompanying the census which was taken December 3, 1867:—

The population of Berlin at the above-mentioned date consisted of 351,253 males and 348,728 females, in all 700,081 persons, exclusive of 2,060 persons forming the river population, and exclusive of the diplomatic body. The number of building sites covered with houses was 13,656, containing 13,376 houses, with frontage to the streets, and 7,484 houses built facing the courtyards, so that there is, upon an average, 51 to 52 inhabitants to every building site, and 33 to 34 to every house; out of a total of 141,756 households, 110,417 occupied houses with frontage to the street, and 42,224 houses built at the back. The number of over-crowded dwellings, with six or more persons living in one room, and ten or more persons living in two rooms, amounted to 15,574, occupied by 111,280 persons, living in 16,489 rooms capable of being heated. The average, therefore, in these over-crowded dwellings was of six to seven persons in one room. The 111,280 persons above mentioned consisted of 31,980 married people and their relations, 58,736 children, 1,997 servants, 2,270 apprentices and youths, 1,006 male and 587 female lodgers, 11,329 male and 2,084 night-lodgers ("Schlafleute"), and 1,291 other persons.

Rents in Berlin naturally vary widely according to the situation of the house, the floor on which the apartment is situated, and internal arrangements, &c.

Unfurnished lodgings for a working man and his family, consisting of one or two rooms with a fireplace (stove), kitchen and sleeping-room, cost from £4 10*s.* to £15 a year. Sleeping accommodation for one person costs about 3*s.* to 4*s.* 6*d.* monthly; this includes a bed and washing apparatus.

III.—Schools.

It is scarcely necessary that I should state that primary education in Prussia is obligatory for all children without distinction, who are not incapacitated by illness or other causes from attending school, from the age of 6 to 14 years. The result of this compulsory system is that of the whole number of children to whom it applies, including those incapacitated as above-mentioned, only about 14 per cent. absent themselves from school altogether, and that of the recruits annually drafted into the army not more than 4 per cent. are found to have received no education whatever, and only 12 per cent. who can read nothing but print. On the other hand, it is thought by many that the guiding principles which regulate the preparatory education of the school teachers as well as the course of instruction given in the primary schools, and which are of universal application, are somewhat too rigid in their uniformity. They do not sufficiently take into account the various degrees of intelligence of the pupils who frequent them, or the great difference that exists between the different provinces of the monarchy—for example, between the east and west—as regards the general standard of intellectual culture.

Exclusive of the higher class of polytechnic and of technical schools, there exist for the benefit of the industrial classes what are called "Fortbildungsschulen," literally schools for education, and which are for the use of young artizans (journeymen, apprentices, and factory operatives) who have passed the period of compulsory attendance at the primary schools.

The course of teaching at these schools is either limited to simply continuing the elementary teaching of the primary schools, or it aims at a somewhat higher degree of instruction, regard being had in most cases to the future industrial career of the pupil. They are totally distinct, however, from technical schools.

Instruction is usually given in the "Fortbildungsschulen" for a few hours only on Sundays, and occasionally on week days. In winter the attendance is more assiduous and frequent than during the summer. Complaints of the irregularity of the attendance at these schools are general, and the education bill which has been introduced this session proposes to invest the communal boards with a discretionary power to make it compulsory for young artizans and factory operatives from 14 to 18 years of age to attend them. The bill in question, however, is an unpopular measure on other grounds, and is not likely to pass.

The total number of "Fortbildungsschulen" existing in Prussia in 1864 was 445, with 493 teachers and 29,123 pupils. This number has no doubt greatly increased since then.

As a fitting conclusion to a report in which I have attempted, as far as my space allowed me, to illustrate by the aid of statistics some of the chief points connected with the material condition of the working classes in Prussia, a short sketch of

their organization and social aims and endeavours at the present moment may not be devoid of interest.

I must first observe that social movements in this country are not to be looked upon or examined as isolated and independent facts. They are closely connected with, and are sensibly influenced by, similar indications of the popular mind in other parts of Germany. What is true of commercial matters is equally true of social movements. On the other hand, the recent attempts which have been made to bring about a close international union, or "solidarité," as the phrase is, between the working classes in the different European states by those who assume to guide and represent them have not hitherto been crowned with much success in Prussia, and the dissensions and bickerings which divide the social leaders and their adherents are as great, if not greater, here than those which separate political parties.

Before the revolution of 1848 the improvement of the condition of the working classes in Prussia was looked upon as a question which concerned the philanthropist more than the statesman. An association called "The Central Union for Promoting the Welfare of the Working Classes," and composed of persons belonging to the official class and of literary men and manufacturers, existed for a long time before it was recognized and sanctioned by the state.

The revolution of 1848, with its confused aims and Utopian legislation, effected nothing permanent towards improving the condition of the labouring classes.

Later on many of the prominent political men belonging to the democratic or popular party, who refused to acknowledge the Prussian Constitution of 1850, retired altogether from the political arena and turned their attention exclusively to economical questions. This circumstance had undoubtedly a beneficial and practical influence in drawing public attention to the extreme importance of such questions. The associations founded by M. Schultze-Delitzsch upon the principle of co-operative credit, and which have now such extensive ramifications throughout Germany, have contributed in a high degree to educate the working classes on economical questions. Whether the purely economical results which have followed the adoption of the principle referred to have really been as important as they appear at first sight admits, perhaps, of some doubt.

Mr. Morier, in his report on this subject which was published in a Blue Book and presented to parliament in 1867, has so fully and ably described the nature, origin, and organism of the co-operative associations established by M. Schultz-Delitzsch, that it would be superfluous to attempt to follow him on the same ground.

On the retirement of the re-actionary ministry of M. Manteuffel in 1859, there was a revival of political life for the first time since 1848, and with it sprung up a number of working men's associations in many of the principal towns. They were usually presided over by highly educated men or persons standing high in public estimation, whose attention, however, was directed more to the mental improvement of the artizans and factory operatives of whom these unions were composed than to any immediate improvement of their material condition. This latter consideration, though obviously not of secondary importance, was put on one side, owing to the dislike which the mass of the working population, even the moderate men amongst them, evinced to the reforms which were proposed for their benefit. It was only when extreme doctrines began to leaven the inert masses of the people, and when all those amongst the unionists and members of economical societies who possessed property of any kind began to look about them for some barrier to arrest the progress of the socialistic movement, that the societies founded by M. Schultze-Delitzsch began to be looked upon with a favourable eye, and have gradually increased in popularity.

In the year 1861 a strong attempt was made by the working men's unions to bring about a combined action and a closer cohesion between them for the purpose of promoting their common interests and objects. The attempt failed in its immediate object, but it had one important result: it established the conviction amongst the working classes that it was only by intimate union and co-operation that improvements in the social and economical condition of the working classes could possibly be effected. These unions still continue to hold annual meetings, but less attention seems to be paid to them than formerly. Although delegates from the Prussian unions are generally present at the international working men's congresses, the members of them as a body are far from being either extreme radicals or socialists. They form the left wing of the Democratic or advanced liberal party, and they have hitherto shown no inclination as a body to change their political flag. A fraction of them, it is true, has declared in favour of the extreme doctrines advocated by the International Association, and has seceded in consequence from the union connection.

A notice, however brief, of working men's associations in Prussia would be incomplete without some mention of a man who, until his death, a few years ago, played so conspicuous a part and exercised so commanding an influence over the masses in this country as Ferdinand Lassalle. He was a man of great intellectual power, eloquence, and subtlety, but of unscrupulous ambition. At a time when the working classes began to be deeply agitated by the social movement to which I have previously alluded, Lassalle enlisted himself with real, or feigned, ardour in their cause, and succeeded in powerfully influencing them by his seductive eloquence and by his writings. Studiously abstaining from any attack upon the ruling powers, he waged war upon the wealthy middle classes and the employers of labour. With considerable skill and plausibility he endeavoured to throw ridicule upon the economical reforms which had been introduced by M. Schultze-Delitzsch for the benefit of the working classes, who were thus divided into opposite camps. Lassalle advocated universal suffrage and state aid as the two cardinal points of his political and economical creed. State aid was to take the form of granting large sums of money out of the public treasury in order to establish manufactories, which were to be the property of the workmen, and to be exclusively under their own control and management. The controversy to which the advocacy of these doctrines gave rise, and which occupied the attention of all classes of the people, was at its height, although it had led to no practical result except the organization under the dictatorship of Lassalle of the General German Working Men's Union, when Lassalle himself was killed in a duel by a M. de Racovitz in Switzerland, in 1865. The memory of this singular man is still cherished amongst the mass of the factory operatives throughout Germany as that of a prophet and martyr; and no one of his present imitators and followers can aspire to a tithe of his influence with the working classes.

Lassalle's death was followed by a serious split in the socialist camp, arising out of the personal quarrels and petty jealousies of the leaders. At the present moment, one of the persons who exercises the most influence in the party is Dr. Schweitzer, a member of the Reichstag, and editor of the "Social Democrat," and he has succeeded in winning over many of his former opponents.

The socialist agitation in this country is a purely negative one. It signalizes itself by hostility to every practical reform, as being nothing more than a mischievous palliative, utter indifference to popular education, and a feeble interest in political progress of any kind. The Union Social Democrats have succeeded, however, in electing five or six members to the North German Reichstag, representing their various shades of opinion. One exception to the negative policy of the socialist party of late has been the encouragement and organization of strikes. In many instances these strikes have ended by the workmen obtaining an increase of wages, and the confidence of the socialist party in their power has been increased in consequence; but the fact is, that the anti-socialist working men's unions have contributed to their success by aiding them when there has been a question of strikes, and, in most cases, where the strikes have been successful, public opinion had already declared itself in favour of the workmen. These strikes are daily, however, becoming frequent and serious, and at the present moment 7,000 miners, working at the coal-mines at Waldenburg, in Silesia, have struck for higher wages and a reduction of the hours of labour. There is a disposition on the part of the owners to yield to these demands, but they refuse to recognize the Trades' Union Committee as a mediating agency, and will only treat with the men themselves.

The recent establishment of "Gewerk-Vereine," or trades' unions, which are quite distinct from the "Arbeiter-Vereine," or working men's unions, is chiefly due to the initiative of two Progressist members of the Reichstag, Max Hirsch and Franz Dunckler, with the object of counteracting the influence and spread of similar organizations established by the democratic socialists, and of promoting the material interests of the artizan labourers in the particular branch of trade to which they belong. They are founded on the principle of excluding political, religious, and intellectual matters, with the sole objects of raising and securing the incomes of workmen, whether employed in trade or manufactures, of establishing invalid, orphan, sick, and strike funds, and of spreading over as large a number of workmen as possible in one branch of trade the expenses which individual workmen, or even local unions, would be unable to bear.

Thousands of workmen up to the present time have joined these "Gewerk-Vereine," and practical results seem likely to flow from them, particularly if they succeeed eventually in obtaining legislative recognition.

As I have frequently had occasion to quote the new industrial code, or law regulating the exercise of industry throughout the North German Confederation, I annex a textual translation of it to this report. It was passed by the Reichstag in June last, and came into operation, with partial exceptions, on the 1st of October.

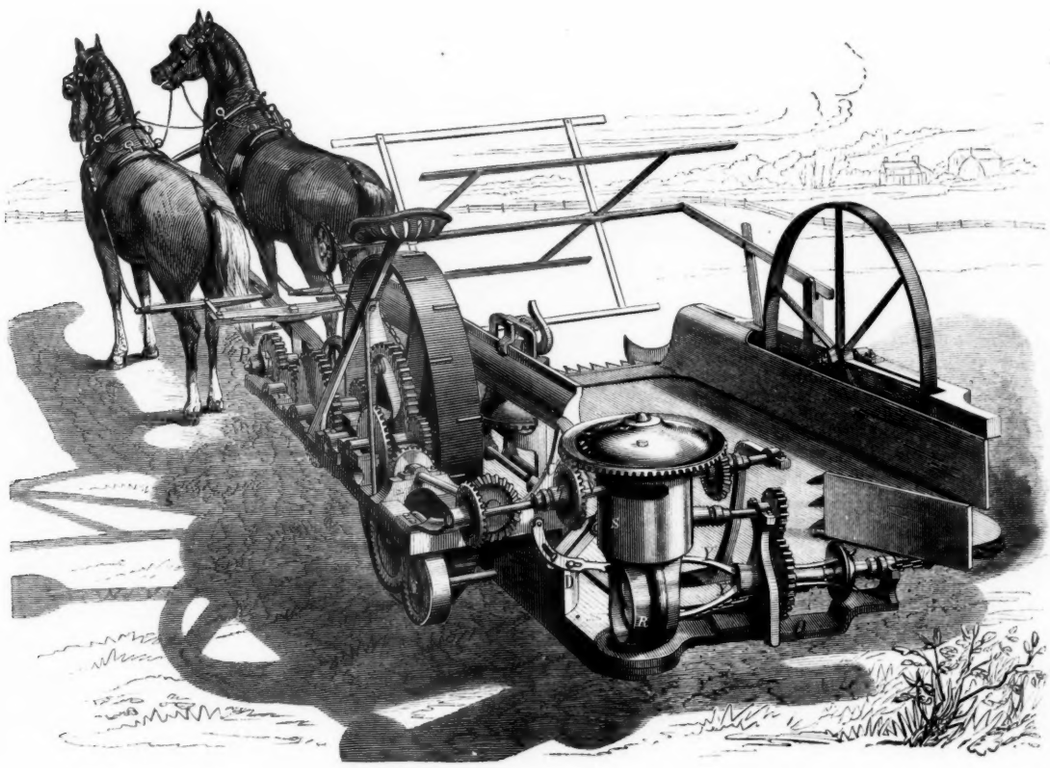
(To be continued.)

GRAIN BINDER ATTACHMENT TO HARVESTERS.

WE present, in the accompanying illustrations, a new attachment brought forward in "The Scientific American" for binding grain on the harvester, immediately after it has been cut, which, it is claimed, operates without any more attention than is necessary to throw the twisting and binding mechanism into or out of gear. The sheaf is held in jaws until a band is twisted from a portion of its straw, then it is turned, rotated, and the band wound around it, secured, and finally the finished bundle is released from the machine.

Fig. 1 is a perspective view, showing more particularly the devices for holding and manipulating the sheaf. Fig. 2 represents the band gatherer and twister, and fig. 3 a section of the bundle with the straw rope partially around it. The rake is arranged on the endless chain, A, operated by means of the gearing at H, fig. 2, in the platform of the harvester. The latter rests on drawing wheels and has suitable cutter and finger bars, with mechanism for operating and adjusting the same. The sickle is placed at B, fig. 2.

In describing the essential portions of this invention, we shall first refer to the twister, depicted in our second figure. On the ends of the rake platform is supported a longitudinal, horizontal frame, C, for the purpose of holding and guiding a sliding carriage, D. A horizontal shaft, E, is hung lengthwise in this frame and connected by the gearing, F, with the driving mechanism. G is a bevel pinion, which, while fitted upon the shaft, E, so as

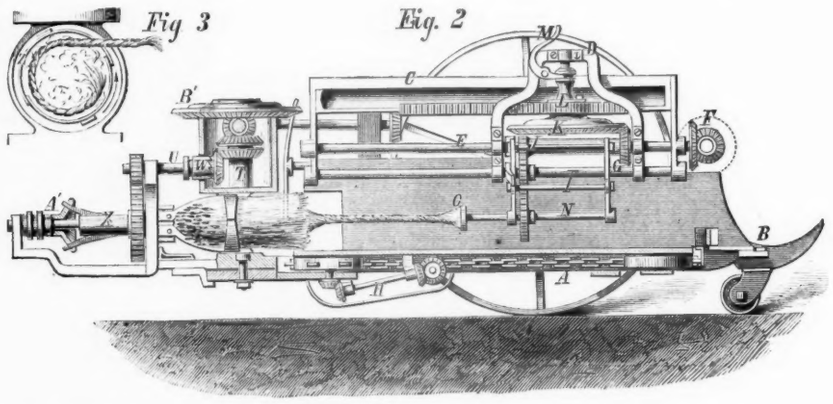


to slide freely thereon, is connected so as to revolve with it by means of a groove and feather. Between the pendent arms of the carriage, which are fitted over the shaft, E, there is arranged upon the latter, besides the pinion, G, above referred to, a frame, I, and between the parts of this frame another pinion, J, which, with regard to the shaft, E, is connected in the same manner as the first-mentioned pinion. The pinion, G, meshes into the teeth of a bevel gear wheel, K, mounted upon a vertical shaft that hangs in the carriage. Loose upon this shaft is a pinion, L, which engages with the teeth of the horizontal rack shown, as constituting a part of the frame, C. Whenever, by means of the clutch, M, the pinion, L, is thrown into gear it will, by its connection with the shaft, E, be revolved and roll on the rack, imparting longitudinal motion to the carriage. In place of this arrangement of rack and pinion, the inventor states that an endless chain may be substituted, thus accomplishing the same object with less working parts. The pinion, J, by the intermediate gearing represented, actuates a horizontal shaft, N, hung in the frame, I, the rear end of which, O, carries a series of hooks or other projections for twisting the straw. The frame, I, is either suspended directly from and hangs with the shaft, N, beneath the shaft, E, or it may be swung to one side by a suitably arranged lever fitting against a rail in the frame, C. By means of a clutch, at P, fig. 1, which connects with the system of gearing, F, the above described apparatus may be readily thrown into or out of use.

To the rear end of the rear platform, fig. 1, and about in line with the frame, C, is pivoted a horizontal plate, Q, which is the bed for the sheaf holder. This plate, for purposes to be described, can be swung in a longitudinal direction, as in fig. 2, or laterally, as in fig. 1. Above the pivot, and affixed to the plate, is a vertical ring, R, above which again is the turret, S, surrounding an upright shaft, T, fig. 2, which is in line with the pivot, and which supports two horizontal bevel wheels, as shown. The lower bevel wheel engages with a similar wheel which is on a horizontal shaft, U, which has its bearings in the plate, Q. The upper bevel wheel meshes into another mounted on a horizontal shaft, V, fig. 1, hanging in the frame of the harvester proper. By means of the clutch at W, the wheel on the shaft, U, is thrown into or out of gear. X is another shaft connected with the shaft, U, by the vertical gearing shown, which is in line with the centre of the ring, R, and holds a pair of jaws, Y Y, which extend within the ring, holding curved clasps, Z, fig. 3, within the same. On the shanks of these jaws is fitted a slide, A', fig. 2, by means of which they can be opened or closed at will. On the upper

part of the turret is shown a large bevel wheel, B′, with which the wheels, C′, on the shaft, V, engage whenever the turret, and with it the plate Q, is to be turned. When the wheels, C′, are not in gear, but the shaft, V, is rotated by suitable connection with the main driving gear of the harvester, and the lower bevel wheels on the upright shaft within the turret are in action, the motion of the shaft, V, is transmitted to the shaft, X, and jaws, Y.

The above details being understood, the operation of the machine is readily followed. Grain enough for one sheaf is by the rake on the chain, A, swept into the cradle while the same is in line with the frame, C, so that the straw will be held in the jaws, fig. 2. Then the carriage, D, is thrown into action by the clutch at P, so that it will move forward on the rack; but before so moving, the pendent frame, I, hanging straight down, has the hooked end of its shaft, N, inserted in the butt end of the sheaf and revolved. As the carriage is moved ahead, the twisters continue to revolve and draw straw from the centre of the sheaf, twisting the same into a band, as represented in fig. 2. When the carriage has travelled far enough to form a rope of requisite



length, the clutch, M, strikes a suitable stop, and is thrown out of gear to release the pinion, L, and arrest the longitudinal motion of the carriage. The wheels, C′, are now thrown into gear with the wheel B′, so as to turn the turret and with it the plate, Q, and entire cradle at right angles to the frame, C, as in fig. 1. The pendent frame, I, is then, by suitable mechanism, swung outward into position, and so supported by a lever before mentioned, that the shaft, N, holding the band, is thereby thrown higher and in proper line with the middle of the sheaf. The clutch, W, is next moved to throw the shafts, U and X, into gear and have them revolved. Thereby the sheaf is rotated in the direction of the arrow, fig. 3, winding the band round it and pulling at the same time the carriage, D, back. The end of the band is then tucked under by the tucker, D′, fig. 1, which consists in a slotted plate connected with a lever and arranged in the position shown. When the lever is swung, the end of the tucker, forming a claw for embracing the band, is carried down and ahead, and thus operated. The slide, A′, is next moved to open the jaws and discharge the sheaf, the cradle is swung round into line with the frame, C, to receive grain for another sheaf, and the lever holding the shaft, N, outwards, is tripped so as to allow the pendent frame, I, to come in line with the centre of the cradle for forming another band.

THE QUANTITY AND THE QUALITY OF OUR WATER SUPPLY.

AT the opening of the Annual Congress of "The British Medical Association," held in London on the 5th of August, Sir William Fergusson, the president, made the following observations on water sanitation in his address. Referring to the subject chosen by his predecessor, Mr. Baker—Birmingham and its Surroundings—he (Sir William) naturally, from the local example of last year, thought what a subject he had before him were he to take London and its environs. With a history well-nigh as old as our knowledge of the island of Great Britain, with a progressive aggregation of humanity larger than the world had ever seen, there were materials for hundreds of addresses, and it might be allowed that the valley of the Thames, however beautiful as regards its surface or interesting as the largest and most populous in our island, lacked much of that special interest which engrossed the attention and occupied the labours of modern men in reference to the mineral products from underground. There was nothing in the London clay, nothing in the geology of the valley of the Thames which could compare in interest with under-surface matters in other parts of the country. There were, however, certain features connected with the valley of the Thames which seemed worthy of special attention; and questions might fairly be raised as to the hygienic condition of the locality. He supposed there could be little doubt that those who planted London as a post or capital looked to the ground on which the Tower stood as a good commanding position on the estuary of the Thames, and that little was thought then of the teeming millions of subsequent inhabitants who would populate the town and valley above. At that date there must have seemed a world of waters sufficient for all after years; the question of drainage would then be little thought of. In primitive times, springs, river sides, and shallow wells were the chief immediate sources of water supply. As years rolled on, where population increased, these resources were found deficient, and additional ones, in a higher style of engineering, were required. He was more impressed regarding the civilization of the Romans, by what they had left indicative of their efforts to give supplies of water when required for health and comfort, than by any other features now extant. The great conduits which testified to the engineering skill of the time, as also to the expenditure incurred in regard to this necessity of life, and the remains of their baths, were ample proofs to this effect. To many it might seem strange that he should refer specially to such a subject on this occasion. It might be thought to pertain chiefly to water companies, engineers, and ratepayers, but in reality it pertains to the public at large, to public hygiene, and in the latter respect peculiarly to this profession; and for such reasons he knew of no section of what is now often called state medicine more interesting than that of water supply "where men do congregate." It was right and fitting, in his opinion, that at a meeting such as this some special reference should be made to the subject. Next to the treatment of disease and accident, it stood foremost in professional minds, for water was as much a question of food as any other dietetic material that can be named. Our supplies of vegetables, of fish, of animal material, came possibly second in importane to this necessary of life. Mother Earth herself took nourishment from her own direct produce—effete vegetation, from the decay of fish, and the *débris* of animal life; but all these would count for nothing if she were deprived of water nourishment. Rational physiology might be called the philosophy of life, and the profession, claiming physiology as one of the highest departments, might claim, as the most skilled conservators of public health, that their opinions regarding water supply should hold due influence over the public mind. It was to the honour of this and all other similar meetings that almost every paper in the sections was devoted to the amelioration, the mitigation, the suppression of disease. In law, man dealt with what man had done or chose to do. In diseases, the profession dealt with causes and courses which, in general terms, might be said were far beyond the ken of man, they came in contact or into collision with nature in varied aspects and phases which the wise thinker in the profession would hardly venture to explain. It was at this point, perhaps, that the profession had

from time to time broken down by attempting too much. Who among them knew what miasm was? What sense was there in the idea that it might be averted or obstructed by coverings, or nets, driven away by fires, or frightened off by artillery? Yet all such theories had obtained more or less favour in the profession, even in the nineteenth century. Who among them could positively, in reasonable terms, define the physical condition of miasm as it once prevailed in the fens and swamps of Lincolnshire, or possibly even now lingered, if it did not dwell, in horrid perfection, on the banks of the Niger? It was to be hoped that the profession might in time be able to appreciate the palpable physical qualities of the great enemy in this shape. They had learnt empirically in time how to knock him on the head by force of quinine, but he was as impalpable now in these days of dengue as in the time of Hippocrates. But to return to common palpable matters irrespective of rivers of Biblical, classical, or strategical interest, there were few to compare with Father Thames. The wealth carried on his surface below London Bridge well-nigh defied calculation. Besides the large share of what might be called our domestic wealth, the argosies of every country in the world were welcome to his waters. There laid the true greatness of the Thames. There seemed no exaction that man could ask from such a father which had not been granted; yet it was most worthy of consideration how far those who had lived and now survived on his banks had dealt fairly with the great stream. The Thames, in his lower course, was one of the greatest highways of commerce ever known to man. In his upper reaches he had been one of the best or worst abused streams that the world had known. He had been at once called to be one of the essentials of life to the inhabitants on his banks, and the cloaca of human aggregation. His streams had been run shallow, and his clear waters had been dimmed by the filthiest pollutions, until the sense of men had, in a manner, revolted at their work. The river thus abused was, in the days of Henry VIII., declared by parliamentary document the finest salmon stream in his Majesty's dominions. This polluted upper stream was a large source of the water supply of the south and west of London. In many respects a "water question" was one of the most interesting in social life. It was as great now as when Moses struck the rock; water was an absolute necessary of life. Many of what were called comforts and luxuries might be absolutely dispensed with; but, without water, both vegetable and animal life would cease. Here, as in many other public and national questions, there was great diversity of opinion. The sources of supply, the quantity, quality, and expenses thereof, formed separate heads, of which various classes of the community took special notice. The quantity and quality were the features in which perhaps the profession were most interested. The public at large probably looked upon the sources and expenses as the most important features; but even here the profession, as ordinary citizens, were as much interested as were their fellows. In regard to quantity and quality, all seemed to agree that there should be the largest and best imaginable of both; no stinted time supply, but a continuous run of the finest. It seemed, however, next to an impossibility to have such in that locality. The Thames could not afford a sufficient supply unless his main stream were nearly run dry; nor did it seem possible, under the circumstances, to render the purity of that quantity such as should satisfy all. Filtering in great tanks on the river-side, in cisterns or vases in houses, scarcely seemed to accomplish this; and he was tempted to say that possibly a fault lay on the side of the profession that they expected too much for themselves, and led the public to expect too much on the score of what might be considered quality and purity. Moreover, they differed largely among themselves in regard to these points. As educated chemists, in reference to animal life and nourishment, they talked and wrote learnedly about elements. The purest water might be defined as that which held least saline, animal, vegetable, or earthy material. The physician thought so highly of this feature that in a fluid dose of medicine he ordered the bulk of the potion of distilled water; yet in that water he probably congregated an amount of saline animal or vegetable material which no natural spring or unpolluted stream could be compared with. He sent his patients hundreds or thousands of miles to partake of waters where the converse of purity was generally the chief feature of the fluid. But this, it would be said, was in accordance with the science of combinations and a just appreciation of the efficacy of salines, especially those compounded by nature in the bowels of the earth. He did not object to those impregnated waters as curative agents in certain forms of disease; he did not quarrel with the physician when he ordered distilled waters as the purest fluid for his compound—but in either instance that physician could not fancy that his patient was about to drink pure water—it might be admitted that he had no such idea, yet the same man insisted stoutly on the necessity for unexceptionably pure water for ordinary drinks. This "Adam's wine" might be filtered, boiled, distilled, yet certain so-called impurities would hold their place or speedily re-appear. Vegetable matter, animal matter, earthy or saline matter, were the bugbear of those who wanted pure water for man. Even the presence of a few fleas, to use a familiar expression, dead or alive, in a great natural basin of water, had been held as an influential objection to a scheme offering a double supply. He then supposed a pint of absolutely pure water given to the meal of the "pet of the day," the "working man," a model teetotaller who had taken a vow against alcohol and all fermented liquors, and asked his hearers to trace the frugal meal—say water and bread—as far as their physiological imagination could, down the intestinal canal and into the blood, and fancy from their knowledge the affluents thereon. Could "pure water" be recognized beyond the teeth in this downward course? Mucus, saliva, tonsillary secretions, mucus again, and gastric juice, and pancreatic, and biliary, all joined the ingredients of the simple meal. But suppose that the working man indulged in the luxury of a bit of beef or mutton, with some of the usual adjuncts—potatoes, turnips, greens, cabbages, peas, or beans—what was the fate of the pint of pure water which was deemed the grand feature of this excellent fare? Here vegetable and animal matter were joined with pure water to an extent a thousand times beyond the imagination of the pure water theorist, and the bread-and-water system was simplicity itself compared with this. He supposed other cases in different classes of society, and he asked, as to the grouse and venison eaters, supposing them to be "pure water" men, what became of the water as soon as it was swallowed? What about the pleasing adjuncts to these delicious articles of food, and what (to those who were always referring to salts in waters) about the common salt which was consumed in quantities so palpably larger than those pointed out by the chemist in so-called saline waters? What could medical men say of the refinement in diet of the savage who preferred animal food in a putrid state to that recently killed, and uses such surface-water, or any other kind, as chance might put in his way? He fancied that the pure chemist was often taken for a medical man, and he feared that many of the profession affected too much the airs of the pure chemist, too frequently jumbled up chemistry and physiology, so that the characters of each seem to suffer. He asked if they were not in reality too fastidious about "pure water?" While the public—no doubt considerably influenced by the opinions of the doctors—haggled over this feature, the more important one of ample supply, for all the purposes of man, was overlooked. Although water for drink was essential to existence, how small in proportion was that, compared with the requirements for sanitary purposes otherwise, such as cleaning, washing, in arts and manufactures? For man's stomach, the requisite quantity of wholesome water was so small that the trouble and cost of purifying by filtering and otherwise would be as nothing compared with the advantage of having what might be called a superabundance. If that superabundance was what the simple housewife called soft, the water desideratum would be fulfilled. He had heard on the best authority that, in Glasgow alone, with a population of nearly half a million, where a large and wise expenditure had been incurred, there had been a saving of something like £40,000 a year for soap, owing to the softness of the water from a natural reservoir, which doubtless was formed by the watershed of the district in which it laid. The good folks of Glasgow tapped the side of one of the most beautiful and classical of Scottish lochs, and brought the water through conduits some 40 miles long to place it at public disposal. The loch was none the worse, and the benefit to the citizens of the second city in the kingdom was, perhaps, incalculable. It seemed almost by instinct that, in the humblest of our cottages, and in most of our moderate, unpretending dwelling-houses, there was a desire to have a supply of rain water. The pump or the nearest open well or spring might be resorted to for water to drink, but the small quantity that can be caught from a stone, tile, or slate roof was eagerly sought by the judicious housewife. The quality of this water suits domestic purposes better than the brightest from well or pump. Largely though this little luxury was indulged in—for the water-butt abounded in every district—it was curious how this sort of instinct had been neglected by many who have catered for the supply of water on a large scale. There were many who approved the project of increasing the supplies of Manchester, Birmingham, and other midland towns, including London, from the natural lakes of Cumberland and Westmoreland. But might not something be done, less stupendous, yet equally effective? Natural lakes, of sufficient bulk, were not to be found in many districts; but might not artificial ones be constructed, which would largely supplement our present water supplies? In most of the upland districts in this country there were spaces, hollows, ravines, and valleys, where—as much of the surface is other-

wise worthless—the water might be dammed up and lake above lake might be made to appear on the landscape. This was no new proposal, and it had been acted upon in countries of ancient historical date, where civilization was never equal to that we now boast of, and the custom prevailed to a considerable extent in this island. Look to the rainfall of a season in this country, and consider how much, or how little, of this gift from heaven was actually used by man. Of all the necessaries of life this was the one which came upon us in this island most bountifully; and yet how much it was neglected. Instead of letting the floods damage our best alluvial soils, destroy vegetable and animal life, endanger man himself, and finally flow uninterruptedly to the sea, might not much of this flood be impounded on our watersheds, and there form small and large reservoirs and lakes, which would be ample supplies of the best water at every season of the year, and even keep in fair volume some of those primitive streams which doubtless were the attraction of those who originally settled on their banks? It was distressing to see, in some of our large towns, to what condition these once fair streams had been reduced; the water was taken off above until the bed of the river had been dried, and then let on again in every imaginable degree of pollution. Under such circumstances, the water thus taken from the stream might be supplemented by the upper stores, or better still, these stores might be relied upon for most of the requirements of large communities. He had seen several severe droughts in this country, and had occasionally wondered what might be the result to animal life—man and beast—if the general distress should continue a few days or weeks longer. This involved a great hygienic question; and, interested as they were in it professionally, taught as all were in the virtues of water—home-distilled, nature-distilled, home-filtered, nature-filtered, looking to the value of water to man as regards his internal and external bodily wants, he did not know any point of hygiene of more interest. Fish, sheep, and cattle can be brought in reasonable quantity—hundreds, it may be—in conserved condition, thousands of miles, but water could not be fetched such distances in sufficient quantity at reasonable terms. And here he could not but again express his opinion that in their professional capacity medical men might err grievously in making trivial and questionable objections to the quality of water when there seemed a fair prospect of getting that which was most desirable for man's use, a full, ever-flowing quantity which might give a perpetual current, day and night, well-nigh fresh from the dew of heaven.

Chemistry applied to the Arts, Metallurgy, Chemical Manufactures, and Allied Subjects.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF CHEMICAL SOCIETIES, &c.

§ 1. *Acids, Alkalies, and Salts.*

Native Sulphuric Acid.—J. W. MALLET states that various springs to the westward of the Neches river, not far from the Gulf of Mexico, contain much free sulphuric acid, amounting in one case to as much as 5·29 grammes per litre, or 370 grains per gallon. The Rio Vinagre in the Andes only contains 1·11 gramme of free sulphuric acid (together with 0·91 of hydrochloric acid) per litre; the water is stated to be sufficiently acid to be used for charging telegraph batteries, this having been actually done during the blockade of the southern ports. *British Association Reports, Brighton Meeting, p.* 78.

Malœic Acid.—BOURGOIN prepares this acid by cautiously heating a mixture of succinate of silver and three times its weight of fine sand; metallic silver and malœic acid are produced, together with small quantities of other products. *Bulletin Soc. Chim. Paris, xx.* 72.

Erythrophenic Acid.—E. JACQUEMIN finds that when chlorine water is added to a mixture of phenol and aniline, a persistent red colour is produced; the further addition of ammonia, fixed alkalies, and their carbonates, developes a fine blue tint. The matter thus produced has very great tinctorial power; it may be obtained in quantity by the addition of hypochlorite of sodium (preferable to the calcium salt) to a mixture of phenol and aniline. Steaming alters the colour speedily, hence its application to dyeing must be somewhat limited; moreover, the faintest trace of acid converts its colour to a red tint. As an indicator of acidity or alkalinity, this substance is far superior to litmus solution. *Bulletin de la Soc. Chim. Paris, xx.* 68.

Trichloracetic Acid.—CLERMONT prepares this substance by oxidizing a strong solution of chloral hydrate with chromic acid, the whole being kept cool; he describes the following salts: *Mercurous* and *mercuric* trichloracetates, and the trichloracetates of *zinc* and of *urea*. *Comptes Rendus, lxxvi.* 774.

Phosphoric Acid.—BLANCHARD, BANG, and POVOST patent the preparation of phosphoric acid in a pure (?) state by treating superphosphate with an equivalent of sulphuric acid, concentrating the liquor till syrupy, heating the residue to redness, and dissolving in water, whereby pure phosphoric acid is dissolved out, insoluble pyrophosphates being left behind; lime and iron are stated to be completely eliminated by this mode of treatment. *Bulletin Soc. Chim. Paris, xx.* 93.

Production of Chlorine.—DE LALANDE and PRUDHOMME have made further experiments, from which they conclude that their statement is correct, viz. that oxygen displaces chlorine from chlorides in presence of an oxide (so-called acid) capable of uniting with the base thus formed (*e.g.* silica, boric anhydride, &c.); and hence that the views of Lamy on this subject are inexact, Lamy considering that the production of chlorine in their experiments is due to the presence of oxide of iron. They find that a mixture of boric anhydride and common salt when heated to redness in a current of dry air for three hours gives off chlorine equal to 15 per cent. of that present, the equivalent quantity of borate of sodium being formed: on the other hand, pure oxide of iron similarly treated only gives chlorine equal to ½ per cent. of that present.

If a mixture of hydrochloric acid and air be used, the former gas immediately decomposes the salt formed, producing water and regenerating the chloride and the anhydride; hence the production of chlorine becomes continuous (provided, of course, the heat is not so great as to volatilize the chloride, and that the nature of the salt formed is such that hydrochloric acid will react on it).—*Bulletin Soc. Chim. Paris, xx.* 74.

Process for Carbonate of Soda Manufacture.—PRACHE patents the well known process of calcination of sulphate of soda with small coal and decomposition of the resulting sulphide of sodium with carbonic acid, the evolved sulphuretted hydrogen being passed into water containing hydrated peroxide of iron in suspension.

In an addition to the patent specification, the patentee proposes to pass the carbonic acid in a solution of sulphide of sodium in which ferric hydrate is suspended. *Bulletin Soc. Chim. Paris, xx.* 92.

Manufacture of Chrome Alum.—LIELEGG reduces bichromate of potassium with sulphuric and oxalic acids; the reaction takes place in the cold, and hence the conversion of the crystallizable salt into the non-crystalline modification does not take place; the liquid is allowed to evaporate spontaneously.—*Dingler's Polytech. Journal, ccvii.* 321.

Colour of Emeralds and Beryls.—GREVILLE WILLIAMS has made a large number of experiments and observations on emeralds and beryls, and concludes therefrom that Vauquelin was quite correct in attributing the green colour to the presence of minute quantities of chromium. Even perfectly colourless beryls and emeralds generally contain small quantities of some carbonaceous substance, which, however, is not the cause of the colour. *Proceedings of the Royal Society, xxi.* 409.

Trachyte Porphyry.—E. T. HARDMAN obtained the following results in analysis of a specimen of this mineral from the Tardree Quarry, Antrim:

Silica	76·960
Alumina	5·101
Peroxide of iron	2·344
Lime	7·064
Magnesia	0·295
Potash	4·262
Soda	1·818
Loss by ignition	2·102
Phosphoric acid	trace
	99·943

Specific gravity, 2·433. *British Association Reports, Brighton Meeting, p.* 112.

Monoxyanthraquinone and Anthraflavic Acid.—C. LIEBERMANN described some time ago monoxyanthraquinone, a compound which is obtained as a by-product in the manufacture of artificial alizarin; afterwards he and Graebe showed that

the same compound is produced by fusing monobromoanthraquinone or anthraquinone-sulphonic acid with potash. A similar compound has been obtained by Schunk from the commercial artificial alizarin, to which he gave the name of anthraflavic acid. Perkin and Auerbach, having investigated Schunk's compound, declared it to be an isomeride of alizarin. Liebermann prepared a fresh sample from the same alizarin from which Auerbach had isolated his compound, and arrived at a confirmation of the results of his former research. *Polyt. Centralbl.* 1872. 1566, *from Ber. D. Chem. Ges. v.* 868.

The Purple of Cassius.—H. DEBRAY considers the purple as a lake of stannic acid, coloured by metallic gold; just as ordinary lakes will not yield up their colours to water, so the gold is prevented by its union with the acid from being dissolved out by mercury. Instead of preparing the purple in the usual way, it may be obtained by first precipitating stannic oxide by boiling together stannic chloride and sodic acetate, then adding gold chloride and potassic oxalate, and again boiling, when metallic gold will be precipitated upon the oxide. A similar colour is produced if alumina be substituted for stannic oxide. Thus it is considered as proved that the purple is simply an oxide coloured by gold. That the purple should be soluble in ammonia is not surprising, if it be admitted to be chiefly made up of stannic oxide, which is soluble in ammonia in the cold. Elevation of temperature and desiccation are preventives to the solubility both of stannic oxide and of the purple. Moreover, the solution, which always appears turbid by reflected light, slowly deposits metallic gold. The latter could not, therefore, have been present as an oxide, since ammonia, in acting upon the oxides of the precious metals, gives rise to products more or less complex, but never to the free metal.

MERCADIEU has observed in the assay of silver containing a little gold and tin, on dissolving the metal in nitric acid, a substance very similar in appearance to the purple of Cassius. It is not, however, soluble in ammonia, and the author thought that this might be due to the metal having been dissolved in hot acid, just as stannic oxide, obtained by oxidizing tin with hot acid, is also insoluble in ammonia. He therefore attacked with nitric acid at a gentle heat an alloy of silver, gold, and tin, and obtained a purple residue quite soluble in ammonia, showing the identity of this residue with the ordinary purple. *Polyt. Centralbl.* 1872, 1561, *from Compt. Rend. lxxv.* 1025.

§ 2. *Metallurgy.*

Improvements in Iron Manufacture. — PARKES decarburizes iron in a Bessemer converter, and then adds nickel or copper, or alloys containing these metals. The decarburization is carried as far as possible, one half the usual quantity of spiegel being added with quantities of the other metals equal to $\frac{1}{8}$ per cent. of the pig-iron used. If the metal is required to be laminated, the alloy added must not exceed 1 part to 60 of iron. As much as 20 per cent. of phosphorus may be added if very fine, easily-worked castings are requisite. The chief characteristic of the process is the almost complete absence of carbon in the metal thus made.

Direct Production of Puddled Iron and Steel.—ESTOUBLON patents the use of a special apparatus composed of three parts: one to reduce and carburize the iron, a second to fuse the carburized metal, and the third to puddle the pig-iron thus produced. *Bulletin Soc. Chim. Paris, xx.* 93.

Steel-making Furnace. — The Société Métallurgique pour l'Exploitation des Procédés Ponsard patents an improvement on a furnace previously described by the society, whereby completely reduced ores can be added to the pig. The furnace consists of several parts: (1) An inclined sole, on which the ores (mixed with charcoal) are reduced without admission of air, hot reducing gases from a generator fed with hot air being employed. (2) A reverberatory furnace in front, in which the gases that have served to reduce the ores in (1) are burnt; this contains a bath of pig-iron, into which the reduced mineral is passed from time to time. *Bulletin Soc. Chim. Paris, xx.* 96.

Improvements in the Manufacture of Steel from Pig-iron.—HENDERSON patents the purification of pig-iron by means of fluorspar, the furnace being lined with a mixture of fluorspar and silica or silicate of alumina; this mixture eliminates silicon, carbon, sulphur, and phosphorus.

The mixture may also be added to the molten pig; a ton of white iron (Cleveland) requires 180 to 250 lbs. of spar with 130 to 180 of silica, or a weight of silicate of alumina equal to that of the spar; an ordinary furnace fettled with oxide of iron is used.

Mixtures of fluorides and carbonates, or fluosilicate of lime and oxides, may also be used. *Bulletin Soc. Chim. Paris, xx.* 96.

On the Distribution of Carbon in Bessemer Steel.—It is well known that by wetting samples of steel with dilute mineral acids, the carbon may be separated out of it in the shape of a fine powder. By thus operating on the latitudinal sections of rails made of Bessemer metal, it has been observed that the central portion is far more affected by the acid than the borders. In a similar experiment on forged samples of Bessemer steel there was also an unequal attacking of the surface, but the inequality was in no way regular,—the more affected and the less etched portions were confusedly mixed up. The following table shows the results of the above-described etching process with six different samples of rails:—

Sample.	In 100 parts.		Difference.
	Amount of carbon in the less etched portion.	Amount of carbon in the more etched portion.	
No. 1	0·2863	0·1432	0·1431
„ 2	0·2285	0·1841	0·0444
„ 3	0·1704	0·1261	0·0443
„ 4	0·1977	0·1227	0·0750
„ 5	0·1738	0·1193	0·0545
„ 6	0·3102	0·2147	0·0955

The author speculates on the probable causes of this migration of the carbon towards the surface, but none of the opinions go beyond mere hypothesis. *Chem. Centralbl.* 1873, 121.

Furnace for Zinc Ores.—The Société Métallurgique pour l'Exploitation des Procédés Ponsard patents the use of gas regenerative furnaces containing a series of vertical tube-crucibles, which stand better than horizontal ones; or horizontal retorts, arranged in a special manner, may be employed. *Bulletin Soc. Chim. Paris, xx.* 93.

Treatment of Metals and Ores.—PAVEN and ROUS patent the use of alkaline oxides, hydrates, or carbonates, for the separation of oxidizable metals from those not readily oxidized. The metals are attacked in the following order:—

1 Arsenic
2 Manganese
3 Zinc
4 Tin
5 Iron
6 Molybdenum
7 Tungsten
8 Chromium
9 Cobalt
10 Nickel
11 Antimony
12 Copper
13 Cadmium
14 Bismuth

The last three are only oxidized by prolonged contact with air, or by addition of some oxidizing agent to the fused alkaline bath. Metals 1 to 9 decompose alkaline carbonates, giving off carbon oxide, and forming caustic alkali. All fourteen metals decompose hydrates, giving off hydrogen, and forming a mixture of oxide and hydrate of the metal.

Steam is blown through the molten liquid to facilitate the action: if lead is to be attacked, or if desulphurization or more rapid oxidation is required, air may be forced through the molten mass; nitrate of soda may be added to complete the oxidation.

Lead containing silver, antimonial or zinciferous lead, argentiferous copper, &c., &c., may be advantageously treated by this process, which is also applicable to the production of chromates, &c.; to desilverize lead, air is forced through until the metal left unoxidized contains about 25 per cent. of silver; this portion is run off and treated again in the same way, nitrate of soda being added. The oxide of lead formed is for the most part left undissolved on treating the mass with water; a plumbate of soda, containing 1 of lead oxide to 13 of soda dissolves; this is evaporated to dryness, and used over again. *Bulletin Soc. Chim. Paris, xx.* 94.

Gold Assays.—H. ROESZLER calls attention to the difficulties which attend the obtaining of correct results in gold assays made by different operators.

In estimating the gold contained in an alloy of gold and silver, a number is obtained which represents the real amount of gold *minus* that lost in the cupel, and *plus* the amount of silver retained. It is asserted by some chemists that these amounts are constant quantities. The quantity of silver retained in gold bars, pre-

pared by the method of Kandelhardt, was found by the author to be ¾ to 1 milligramme.

In gold bars from various sources the quantity of silver varied from 1½ to 3 milligrammes. If, therefore, the bars are invariably prepared by one and the same method, the amount of silver retained is a constant quantity. The gold lost in the cupellation process is greater, the greater the amount of lead used, and less, the greater the amount of silver present. In general assays the loss of gold is greater than the amount of silver retained.

The following table shows the excess or loss in fourteen estimations :—

Composition of the alloy.	Excess or loss calculated upon 1,000.
1,000 Gold	± 0·2
900 G. } 100 Copper }	— 0·66 / — 0·33
500 G. } 200 Silver } 300 C.	— 2
500 G. } 500 C. }	— 3 / — 2·5
500 G. } 250 S. } 250 C. }	— 1
500 G. } 500 S. }	— 2
250 G. } 750 S. }	0
250 G. } 500 S. } 250 C. }	— 2
100 G. } 900 S. }	0
100 G. } 800 S. } 100 C. }	0
22½ G. } 977½ S. }	0
0·5 G. } 999·5 S. }	0
50 G. } 950 S. }	+ 2
50 G. } 950 S. }	+ 0.5

In the last estimation the boiling in nitric acid of 1·3 spec. grav. was twice performed; in all previous cases only once. *Polyt. Centralbl.* 1872, 1534.

Gold-Plating.—C. WINKLER says that in consequence of the great competition in the manufacture of gilded jewellery, and the resulting lowering of the prices, the quality of the articles has suffered in a somewhat similar ratio, until at length in Paris, Vienna, and other towns, articles are being freely sold as gilded, gold-plated, or as composed of a newly invented species of gold (talmi-gold), which in fact contain little more than a trace of the noble metal as a thin plating, either of the pure metal, or more usually of an alloy containing from 0·05 to 0·97 per cent. of it, and frequently none at all. This talmi-gold was first used in Paris for the manufacture of ornamental wares, trinkets, &c., and these articles possessed great beauty and durability. The material for the preparation of the talmi-gold articles is obtained by rolling out gold-plated copper, pinchbeck, or brass plates, or drawing out to wire, in which processes the underlying copper, pinchbeck, &c. still retain their gold covering, which not only possesses remarkable strength, but is also more intimately united with these underlying metals, adheres more closely, and has not the porosity of the layer deposited in electro-gilding. The amount of gold contained in talmi-gold used in plating other metals or alloys seldom exceeds one per cent., and yet this offers great resistance to atmospheric action, sulphurous vapours, &c. The following is the result of the analysis of a portion of a talmi-gold chain, which for four years had been worn constantly without deterioration by tarnishing, &c. :—

Copper	89·88
Zinc (overlaid portion)	9·32
Gold (contained as gilt covering)	1·03

On treatment with nitric acid, the central portion was dissolved, leaving the gilt covering in thin, partially corroded tubes. *Polyt. Centralbl.* 1872, 1539.

Simple method of Gilding Iron by the Dry Process.—Sodium amalgam was found by W. KIRCHMANN to be an advantageous means of simplifying the method of dry-gilding iron, and of painting gold designs thereon. It is sufficient simply to rub iron or a similar metal, even when oxidized, with this amalgam, in order to have it immediately amalgamated. A concentrated solution of chloride of gold is then quickly applied to the amalgamated surface, and the mercury driven off by heat. The gilding thus produced is very uniform, and capable of high polish.

Corresponding results can be obtained with silver and platinum salts. *Polyt. Centralbl.* 1872, 1624.

§ 3.—*Dyeing, Calico Printing, and allied Subjects.*

Extract of Madder.—TOURRE patents a special apparatus for the extraction of a pure colouring matter from acidified madder by means of alcohol, or for the treatment of crude madder or any of its derivatives. *Bulletin Soc. Chim. Paris, xx.* 91.

Phenolcyanine.—PHIPSON describes under this name a blue substance obtained by allowing an alcoholic solution of ammonia to act on phenol; it appears to present some analogy with the colouring matters of the lichens, *e. g.* orceine; it has only been imperfectly examined as yet. *Chemical News, xxvii.* 708.

Analysis of Iron Mordants.—H. VOHL gives directions for determining chlorine, nitrous and nitric acids, and ferrous oxide, the presence of the last three being in general deleterious. *Musterzeitung, xxii.* 2.

Adulteration of Albumin.—HERBURGER states that gum, dextrin, starch, &c. are frequently used to adulterate albumin. To recognize such sophistications, thirty grams of the albumin to be tested are dissolved in luke-warm water; insoluble white masses indicate overheating during the preparation, and the consequent production of coagulated albumin. Starch is sought for by addition of iodine; gum, by adding acetic acid, decanting, and adding alcohol, which precipitates gum; sugar may be found by Fehling's test (reduction of copper solution to suboxide). *Musterzeitung, xx.* 19.

New Process for Indigo Dyeing.—SCHUTZENBERGER and LALANDE find that the so-called "hydrosulphite of soda" (the body produced by the reducing action of zinc on sodium bisulphite, and indicated by the formula $Na\,H\,SO_2$) can be used with advantage to reduce blue indigo to white. Bisulphite of sodium solution at 30° to 35° B. is brought into contact with plates of zinc (or zinc clippings, filings, &c., so as to have as large a surface action as possible) for an hour; milk of lime is then added so as to precipitate the zinc salts, and the whole filtered, contact with air being avoided as much as possible; the liquid is then mashed with indigo, and as much lime or soda as may be requisite to dissolve the reduced indigo formed; a clear yellow liquid is immediately produced, the only impurities being the earthy matters contained in the indigo used. A concentrated indigo-vat, containing 1 kilog. of indigo in from 10 to 15 litres of fluid, can thus be made readily. This indigo liquor is then poured into water, so as to give a bath of the strength required. For cottons the water may be cold, for woollens at a gentle heat. The vat being quite clear, the dyeing is carried out rapidly, any required depth of tint being communicated by a few dippings, the strength of the bath being under perfect control, according to the quantity of concentrated reduced indigo liquor added. This process gives clearer and more solid tints than those obtained with the ordinary vat.

The reduced indigo solution can be used for printing, a considerable excess of "hydrosulphite" being added to prevent oxidation during use, and the whole thickened with gum, or other thickener, to the required extent. The printing is effected in the air (and not in an atmosphere of coal-gas), and clearer and more solid tints are obtained in this way than can be with indigo reduced by the usual process. As no treatment beyond exposure to air is required to develop the indigo blue, this colour can be used simultaneously with many others, such as aniline black, garancine, and madder colours obtained by dyeing or steaming, &c.; albumin colours, chromes, &c. &c., and many styles of goods, can be produced thus which cannot readily be executed by any other process. Specimens of such goods accompany the original paper. Hydrosulphite blue and aniline black are simultaneously printed and fixed; and hydrosulphite blue with garancine red. Twelve to twenty-four hours' exposure to air suffice to fix the indigo completely, after which the pieces may be washed and soaped. *Moniteur Quesneville, July*, 1873, *p.* 655. *Bulletin. Soc. Chim. Paris, xx.* 7.

"Gris d'Alsace."—This is an aniline colour, prepared by M. SINGER, which can be applied to wool, cotton, and silk, without mordants. By the addition of some acetic acid to the bath containing the colour a somewhat blueish tint is produced, whilst the admixture of a little soda or soap solution yields a reddish tint. Semi-woollen goods require mordanting

with alum or tannic acid solution. The use of mordants is also recommended for wool, cotton, and silk where these materials are to receive deeply tinted colours. *Polyt. Centralbl.* 1872, 1626.

Dyeing Straw with Aniline Green.—M. HARTMANN prescribes the following method applicable in the case of straw for straw hats, artificial flowers, &c. The straw is placed for some time in boiling water, then washed in cold water, and afterwards bleached in a bath containing 20 grammes of chloride of lime and 7 to 9 grammes of sulphuric acid. No more water is used than is necessary to work the straw about in. The straw is now rinsed in cold water, then wrung out and brought for a quarter of an hour into a solution consisting of sumach, tartaric acid, and alum, dissolved in not too much of water. About half the mordant solution is now poured off and replaced by pure water. Aniline green and picric acid are then added to the bath, so that the required tint is produced, the straw being agitated in the solution for some time. *Polyt. Centralbl.* 1872, 1562.

Dyeing Cotton with Fuchsine.—The articles (100 pounds) having been steeped over night in a turmeric bath (containing 30 pounds) are taken out, whilst the bath receives 6 pounds of hydrochloric acid; the goods are then passed five times through the acidified liquor, rinsed in water and wrung out. A solution of 10 pounds of plumbic acetate is mixed with a solution of 6 pounds of alum, the clear liquid decanted from the precipitate formed, the articles several times passed through this liquid, wrung out, and placed for a quarter of an hour in a bath containing 12 ounces of fuchsine of a yellow tinge. *Polyt. Centralbl.* 1872, 1563.

Black-staining of Wood.—It is customary to employ for the staining of wood the clear liquid obtained by treating two parts of powdered galls with 15 parts of wine and mixing the filtered liquid with a solution of iron protosulphate. Reimann, in his "Färber-Zeitung," recommends the use of water in the place of wine. *Polyt. Centralbl.* 1872, 1564.

To Impart to Wood the look of Mahogany.—The wood is first painted with a solution of glue containing iron oxide, and when dry, varnished. The varnish is prepared by mixing a solution of 1 part of acaroid-resin in 3 parts of alcohol (90 % strength), with a solution of 10 parts of shellac in 40 parts of alcohol (80 % strength), and subsequent decantation of the clear portion from the sediment. The wood may be covered with this varnish twice or even three times. *Polyt. Centralbl.* 1872, 1563.

Indestructible Ink.—A very little quantity of aniline black triturated with a mixture of alcohol and hydrochloric acid, and the liquid obtained diluted with about twice its weight of water containing a trace of gum arabic, gives an ink which proves indestructible alike with respect to strong mineral acids and towards concentrated lyes. *Bayer. Ind.-und Gew. Blatt*, 1873, 74.

§ 4. *Heating, Illumination, Oils, Fats, Photography, etc.*

Manufacture of Fatty Acids.—W. L. CARPENTER states that saponification of fats with lime is disadvantageous, either 60 per cent. above the theoretical quantity of lime being required, or else a very high pressure. When water alone is used as a distilling agent the great pressure employed often bursts the vessels; great waste of materials often occurs and there is great risk of fire.

Fats consist of globules of fatty matter enclosed in envelopes of albuminous material, these envelopes constituting about 1 to 2 per cent. of the fat; heat, alkalies, pressure, &c., destroy these envelopes; but the same result is more conveniently obtained by treatment with certain oxidizing agents whereby the albuminous matters are rendered so dense that they readily subside (after rupture of the envelopes and escape of the fatty matter). When tallow heated to 115° C. is well agitated with 6 per cent. of sulphuric acid for a short period, these albuminous envelopes are charred and burst open; if water is then added and the whole boiled for some time the blackened but still neutral fat is gradually decomposed; when the change is complete, the aqueous liquid is run off and the glycerine contained extracted by neutralizing the acid with lime and evaporating. The blackened fatty acids are subjected to the action of sulphuric, nitric, and hydrochloric acids, bichrome, permanganate of potash, and bleaching powder, or other suitable oxidizing liquor; the albuminous matters coagulate together and subside, leaving the fatty acids of a pale brown colour; these are then washed, crystallized, pressed, &c. &c., in the usual manner.

By this process a larger yield of stearic acid per ton of tallow may be obtained than by the ordinary methods, the acid being also whiter and harder; the elaidic acid obtained also is superior to that made in any other way. *British Association Reports, Brighton Meeting for* 1871.

Detection of Arachis-oil in Olive-oil.—Among the various substances employed in the adulteration of olive oil, the oil of the seed of *Arachis hypogæa* frequently occurs. A. Renard recommends for its detection a somewhat tedious but sure process. About 10 grammes of the oil to be investigated is saponified with caustic soda, the soap decomposed by hydrochloric acid, the liberated fatty acids dissolved in 50 cc. alcohol of 90 per cent., the alcoholic solution is treated with lead acetate, the precipitated lead-salts are shaken up with ether, which dissolves out the plumbic oleate, and the rest of the lead-precipitate is decomposed by hydrochloric acid, when palmitic and arachic acid will be set free. The two acids are separated by means of hot alcohol, which dissolves them both, but out of which the arachic acid separates on cooling. This acid is recognized by its fusing point, which is 75° C., but 70° or 71° may be considered as sufficiently characteristic, since in the above-described separation the arachic acid will always retain some palmitic acid. *Polytechnisches Centralblatt*, 1872, 1628, *from Journ. de Pharm. et de Chim.*

Decolorization and Sweetening of Oils, especially those extracted by Bisulphide of Carbon.—BEAN and COMMAILLE add to the oil (kept in wooden vessels and at such a temperature as to be at least partly liquid) permanganate of potash solution, and agitate thoroughly; a quantity of hydrochloric acid just equivalent to the permanganate is then added, so that no free chlorine is evolved, but only nascent oxygen: 1 kilogram of permanganate requires 3·159 kilogr. of acid at 20° B.

Or otherwise, the oil is mixed with a solution of chlorate of potash and intimately mixed: hydrochloric acid is then added as before, 1 kilogram of chlorate requiring 1·755 kilogr. of acid at 20° B. *Bulletin Soc. Chim. Paris, xx.* 92.

Oils of Nutmeg and Orange-peel.—C. R. A. WRIGHT presents a report on the results of a large number of experiments made on these oils with a view to elucidating their chemical constitution and relationships to other allied substances. *British Association Reports, Brighton Meeting, p.* 313.

J. H. GLADSTONE also presents a report on the optical and physical properties of many of the substances described in the above paper. Ibid. p. 311.

Ozokerit Candles.—LETHEBY gives the quantities (in grains) of different materials which are required for giving the same amount of light as 1,000 grains of spermaceti:—

	Grains.
Ozokerit candles	754
Paraffin „ of different kinds . .	798-891
Spermaceti „	1,000
Wax „	1,150

Ozokerit candles have the further advantage of not softening easily in the warmer season, the fusing point of ozokerit being high.—*Polyt. Centralbl.* 1872, 1566.

Impurities in Coal-Gas.—R. GASCH found a variety of bodies in the tarry deposits of the connecting tubes in gas works. Many of them distil over below 65° C., amongst others an oil, boiling at 45° and containing large quantities of carbon disulphide. The gas, which has to pass through these tarry liquids, is, of course, charged with these volatile matters. The amount of these impurities admixed to the gas varies according to temperature, season, and locality; being less at the place of consumption than nearer to the gas works.—*Chem. Centralbl.* 1873, 56.

Ignition of Oily Cotton.—J. GALLETLY finds that when cotton waste is soaked in various kinds of oil, and then wrung out and exposed to a temperature of about 170° F., it frequently rapidly heats, and finally takes fire. The following results are given:—

Boiled linseed oil set on fire in from 60 to 105 minutes.
Raw „ „ 4 „ 5 hours.
Rape oil „ 6 „ 10 „
Coal and shale oils produce no heating at all.
Mixture of coal and shale oils with 20 per cent. rape oil produce no heating at all.

At a temperature (initial) of 130° F., the following results were observed:—

Gallipoli olive oil set on fire in from 5 to 6 hours.
Castor oil „ 1 to 2 days.
Lard „ „ 4 hours.
Seal „ „ 100 minutes.
Sperm oil, no charring of the waste produced.

It hence appears that drying oils are not necessarily more liable to produce this so-called "spontaneous combustion" than certain non-drying oils, *e. g.* seal oil. The protection afforded by coal and shale oils probably arises through the exclusion of air through the partial volatility of such substances.—*British Association Reports, Brighton Meeting, p.* 73.

Reproduction of Negatives.—P. E. LIESEGANG described some time ago the following process for the reproduction of negatives :—A glass plate is covered with a solution containing gum, honey, sugar, glucose, and ammonic bichromate, dried under the negative, exposed to light, and dusted over with powdered black chalk. Since only those parts of the coating which have not been under the influence of light remain hygroscopic, the chalk attaches only to them. Somewhat later Geymet and Alker proposed the same method, substituting, however, graphite powder for the chalk; but Liesegang continues the use of chalk, as in many ways more advantageous. Geymet and Alker's process is the following :—

A solution containing—

100 cc. water.
10 gram. gum arabic.
10 „ glucose.
2 „ sugar.
½ „ honey.
20 cc. saturated solution of ammonic bichromate

is poured over a glass plate, the plate is dried over a spirit lamp, exposed, when dry, under the negative to light, in sunshine for two minutes, in shade for five or six minutes, and developed with graphite powder. The best quality of powder is that obtained by sifting through a wire sieve of No. 200; for landscapes No. 100 does well enough. The best method for the elimination of the chrome salt is to cover the picture with collodion and then to wash it.—*Chem. Centralbl.* 1873, 106.

Abertype.—This is the name of a photo-lithographic process patented for the United States by J. Albert. The whole process consists of seven operations, viz. :—the preparation of the negative, the separation of the collodion picture from the glass-plate, the coating of the matrix, the covering with the sensitive film, the printing off the matrix, the transferring to the lithographic stone, and, finally, the printing from the stone. For the details of the execution we must refer to the original description. *Polyt. Centralbl.*, 1872, 1618, *from Photogr. Arch.*

Pyrometers for High Temperatures.—The committee appointed to report on Siemen's Electrical Resistance Pyrometer find that the resistance of the coil of wire used in the pyrometer is about three and a-half times as great at a red heat as at the ordinary atmospheric temperature; after heating, the resistance at any given ordinary temperature is rather greater than it was previously; the permanent change thus produced becomes less and less at each successive heating, and it seems highly probable that after a certain number of successive heatings to redness, the wire reaches such a condition that no further change is produced by heating to redness. *British Association Reports, Brighton Meeting, p.* 134.

Air-Frigorific Machines.—ARMENGAUD states that the source of cold in these machines is obtained by first condensing and cooling air, and then allowing the air to expand, thereby moving a piston and producing mechanical force, which can be utilized to compress fresh portions of air. In order to cool the compressed air (which necessarily becomes heated during the compression), injection of water into the pump-cylinder while the compressing process is at work, appears the most preferable method; the effective motive power required for the production of cold by the mechanical expansion of gases depends (for a given mass) only on the initial temperature of the gas on entering the machine and on the amount of expansion: the nature of the gas has no influence on the result. If the expansion is 2, and the gas be cooled *during* compression, the requisite motive power is only one-half of that requisite when the cooling is performed *after* compression; the value 2 for expansion seems to be preferable to any other, as the motive power requisite increases with the expansion, and consequently the expansion should be kept as low as is compatible with the production of the degree of cold required. With 2 for expansion (the gas being cooled during compression), one horse power (270,000 kilogram-metres per hour) is theoretically capable of freezing 41 kilograms of water at 20°. *Comptes Rendus*, 76, 626.

Fusee Threads.—R. BOETTGER treats cotton threads with nitric acid, then with a mixture of nitric and sulphuric acids, steeps the material afterwards in a weak solution of soda, and finishes with careful washing and rinsing in cold water. The material having thus been converted into gun-cotton, may be dyed with a solution of fuchsine in alcohol. *Chem. Centralbl.*, 1873, 107.

§ 5. *Food, Water, and Sanitary Matters.*

Tannin in Wines.—BEJIN states that the wine of Bagnols-Saint-Raphael is the richest in tannin of any known, and that when used in hospitals, &c., it produces the same tonic results as quinine wine without being so disagreeable to the palate as the latter; from 25 to 50 grammes (¾ to 1½ ounces) suffice after each meal. *Les Mondes, xxxi.* 180.

Treatment of Fermenting Liquors.—MARGUERITTE boils saccharine liquors with a little free sulphuric or phosphoric acid or superphosphate of lime; the production of fusel oil and bad smelling and tasting products is thus rendered much less in amount when the liquors are subsequently fermented. *Bulletin Soc. Chim. Paris, xx.* 44.

Linseed Cake.—A. VOELCKER states that the best linseed is apt to contain about 4 per cent. of foreign seeds (weeds, &c.), whilst inferior or purposely adulterated specimens contain 40 per cent., and even more; 23 species of seeds are described, of which *Linum catharticum*, *Lolium temulentum*, *Sinapis arvensis*, and *Githago segetum* are the most injurious; *Raphanus Raphanistrum* and *Camelina sativa* possess a disagreeable flavour; many of these seeds contain nitrogenous matters, the percentage of nitrogen ranging from 0·90 (*Spergula arvensis*) to 3·99 per cent. (*Sinapis alba*).

The best feeding cake is that from the Baltic; it is darker and more nitrogenous, and gelatinizes with water more readily than that from Bombay seed; the American and Marseilles cakes are usually pure, but rather hard-pressed; Hungarian and Neapolitan cakes often contain oats and other grains. As a rule, the thinner the cake the less oil is present.

Cakes from other sources than linseed are often mixed with linseed cake; those from locust beans, rice-meal, bran, German rape, earth nut, sesamé, and niger seed (*Guizotea oleifera*), being of most frequent occurrence. Indian rape is often mixed with so much mustard as to be injurious to animals; beechnut cake contains a volatile substance said to be an injurious narcotic. Cocoa bean cake is made from the bean shells, the kernel being used for chocolate making. Palm nut cake is made from the fleshy part of the oil palm fruit, palm kernel cake being manufactured from the kernels of the same plant. Olive oil cake varies much in composition. Castor oil cake is injurious to animals, but is a valuable manure, containing 8·69 per cent. of nitrogen. The beans of *Jatropha Curcas* are highly poisonous, but nevertheless Curcas cake has been found admixed with feeding cake. "Siftings" cake (prepared from the screenings of dirty linseed), dari grain (the seed of *Andropogon Sorghum*), cocoa nut fibre, and many other rubbishy adulterants, are frequently found in oil cake. Cake containing locust bean cake is very liable to attract moisture from the air, and consequently to become mouldy on account of the large quantity of sugar contained in the locust beans.

Pure linseed cake contains no starch; hence iodine is a good test for bran and starchy seeds generally; most of the other foreign ingredients are best detected by the microscope, for which purpose the author gives numerous drawings of magnified sections. Frequently, injurious effects are produced, not by the presence of any really poisonous ingredient, but by the mouldy state of some of the constituents of the cake.

The following tables illustrate the per-centage composition of linseed and other of varieties cake seeds.

	Linseed.		Locust bean.	Brasia nuts.
	High per-centage.	Low per-centage.		
Moisture	10·64	5·47	14·64	6·54
Oil	38·21	30·78	1·08	40·40
Albuminoids	26·62	19·31	7·03	9·31
Soluble carbo-hydrates	26·22	17·30	68·03	32·41
Woody fibre	11·40	5·91	6·34	8·24
Ash	4·57	2·76	2·88	3·10
Nitrogen	4·26	3·09	1·13	1·49

	Dari grain.	Decorticated Acorns.	Rice meal.	Bran.
Moisture	13·14	40·88	8·67	12·86
Oil	3.30	2·64	7·59	5·56
Albuminoids	7·75	4.39	7·75	13·80
Soluble carbo-hydrates	68·45	46·74	39·98	50·17
Woody fibre	4·72	3·94	21·98	11·50
Ash	2·64	1·41	14·03	6·11
Nitrogen	1·24	0·70	1·24	2·24

	Rice Husks.	Oat Husks.	Flax Chaff.	Palm Kernel Shells.
Moisture	9·80	11·98	14·60	10·12
Oil	1·10	0·36	2·82	1·51
Albuminoids	4·18	1·25	4·75	2·93
Soluble carbo-hydrates	44·94	53·63	27·28	16·37
Woody fibre	26·80	28·48	43·12	67·90
Ash	13·18	4·30	7·43	1·17
Nitrogen	0·67	0·20	0·76	0·47

The following tables illustrate the composition of some of the cakes used for feeding purposes :—

	Linseed.		German Rape.	Sesamé.
	High per-centage.	Low per-centage.		
Moisture	14·93	9·44	10·82	8·06
Oil	15·84	9·88	8·72	11·34
Albuminoids	35·31	23·25	33·81	36·87
Soluble carbo-hydrates	36·86	20·06	28·05	25·05
Woody fibre	15·38	8·58	11·49	8·14
Ash	8·73	5·40	7·10	10·54
Nitrogen	5·65	3·72	5·41	5·90

	Cotton Seed.		Earth Nut.	
	Unde-corticated.	Decorti-cated.	Unde-corticated.	Decorti-cated.
Moisture	11·46	9·28	8·10	9·26
Oil	6·07	16·05	8·76	5·58
Albuminoids	22·94	41·25	30·50	43·43
Soluble carbo-hydrates	32·52	16·45	27·78	31·39
Woody fibre	20·99	8·92	19·12	5·18
Ash	6·02	8·05	5·74	5·16
Nitrogen	3·67	6·58	4·88	6·95

	Niger Seed.	Hemp.	Poppy.	Palm Nut.
Moisture	12·56	11·59	11·63	8·67
Oil	5·38	7·23	5·75	9·82
Albuminoids	32·81	33·50	31·46	35·56
Soluble carbo-hydrates	20·31	15·56 } 38·18		{ 18·50
Woody fibre	21·08	23·74 }		{ 17·05
Ash	7·86	8·38	12·98	10·40
Nitrogen	5·25	5·36	5·11	5·69

	Foreign Palm Kernel.	Beech Nut.	Cocoa Nut.	Cacao Bean.
Moisture	11·91	11·44	8·97	14·95
Oil	7·48	5·22	11·44	8·02
Albuminoids	18·25	18·81	20·75	19·87
Soluble carbo-hydrates	41·16	18·81	20·75	19·87
Woody fibre	17·05	23·52	14·27	18·26
Ash	3·30	4·84	5·16	6·44
Nitrogen	2·92	3·01	3·32	3·18

	Indigo Seed.	Linseed Siftings.	Olive.
Moisture	11·91	10·57	13·41
Oil	4·01	6·45	3·10
Albuminoids	18·15	18·44	6·01
Soluble carbo-hydrates	47·96	35·94	30·66
Woody fibre	11·88	14·13	38·24
Ash	6·09	14·47	8·58
Nitrogen	2·90	2·95	0·96

Journal Royal Agricultural Society [2] *ix.* 1.

Pepsin.—WOLFFHÜGEL describes experiments from which he deduces the following conclusions :—

1. Pepsin will not dialyse.
2. As Freidinger, Fick and v. Wittich have shown, pepsin is not produced by the pyloric glands.
3. Hydrochloric or nitric acid diluted till the liquid contains only 0·4 per cent. of acid can convert boiled fibrin into peptones at a temperature of 60°, but the change takes place very slowly.
4. At 40° the power of forming peptones begins to show itself, hydrochloric acid being more rapid than nitric at this temperature.
5. Wherefore, nitric acid is preferable to hydrochloric for the detection of pepsin. *Pflüger's Archiv, vii.* 188.

Cyclamin.—S. DE LUCA finds that the tubers of the *Cyclamen europæum* contains a poisonous principle, *cyclamin*, together with a fermentible saccharine substance, starch, and gum; the toxic action of cyclamin is analogous to that of curara, but is less energetic; 10 or 20 grains of the expressed juice will not kill rabbits when introduced into their stomachs, nor are pigs affected by eating the tubers; fishes, however, are poisoned by water containing 1 cc. of juice to every 3 or 4 litres.

The juice of the tubers spontaneously ferments in contact with air; mannite appears to result from the fermentation, as it is obtained from the fermented juice, but not from the fresh tubers. *Gazzetta Chimica Italiana, ii.* 556.

Softening Water by means of Lime.—STINGL recommends that the quantity of lime that should be added to calcareous water in order to soften it should be estimated by titrating the carbonates of lime and magnesia contained in a portion of the water (100 cc.) with a solution of lime-water, the value of which is known by comparison with a standard acid solution; thus the quantity of lime to be added to each cubic metre of water can be calculated exactly, and an excess or a deficiency of lime avoided. Excess of lime-water is very objectionable, as the boiler-crust formed in such cases is very hard. *Dingler's Pol. Journal, ccvi.* 304.

Sulphur Springs from Lostorf (Solothurn Jura).—BRIGEL gives the following analyses of water from two wells, (A) and (B).

Well (A).

Potassium sulphate	0·6714
Sodium chloride	3·0200
Magnesium carbonate	0·2048
Alumina and phosphoric acid	0·0130
Silica	0·0226
Calcium carbonate	0·3425
Potassium trisulphate	0·0734
Potassium sulphide	0·3284
Ferrous carbonate	0·0087
Total solids	4·6848
Half-combined carbonic acid (Or 66·05 ccs. at 0° and 760 m.)	0·1310
Half-combined sulphuretted hydrogen (Or 59·8 ccs. at 0° and 760 mm.)	0·0911

Well (B).

Chlorine	1·4270
Carbonic acid	0·3620
Sulphuretted hydrogen	0·1585
Sodium chloride	2·3515
Calcium carbonate	0·8236
Sulphur	0·1492

N. Report. Pharm. xxii. 75.

Analysis of the Stahlbrunnen at Homburg.—FRESENIUS gives the following results :—

Gas evolved per hour	12 litres.
Water „ „	90 „
Temperature of water	18·75° (air being 11°)
Specific gravity, at 20°.	1·00708

Composition of Gas.

Carbon oxide	87·57
Nitrogen	12·07
Light hydrocarbons	0·36
Sulphuretted hydrogen	trace
	100·00

Water contained in 1000 *parts :*

Sodium chloride	5·863199
Potassium „	0·248320
Lithium „	0·012067
Ammonium „	0·013187
Calcium „	9·497721
Magnesium „	0·315457
Magnesium iodide	0·000015
Magnesium bromide	0·000676
Potassium nitrate	0·001874
Calcium sulphate	0·003725
Strontium „	0·010619
Barium „	0·000420
Calcium carbonate	0·722479
Magnesium „	0·061417
Ferrous „	0·071385
Manganous „	0·004054
Nickel and cobalt	0·000024
Silica	0·017190
Total solids	7·844843

Cæsium	oxide	Of each a trace.
Rubidium	„	
Aluminium	„	
Copper	„	
Antimony	„	
Arsenic acid		
Boric	„	
Fluorine		
Organic matter		*J. Pr. Chem.* [2] 7. 20.

Mineral Waters of Java.—REICHARDT gives the following analysis of the Genock Watoe spring, one of many containing considerable quantities of iodine.

100 *grammes of water contain*—

Potassium chloride	0·0303 grammes.
Sodium chloride	2·3006
Sodium iodide	0·0138
Sodium bicarbonate	0·1720
Magnesium chloride	0·0334
Calcium sulphate	0·0036
Calcium bicarbonate	0·0687
Sodium silicate	0·0058
Ammonia nitrate	0·0050
Ammonia bicarbonate	0·0306

Arch. Pharm. [3] *ii.* 130.

Utilization of Sewage.—The committee re-appointed on this subject have made a large number of further experiments and observations, from which they conclude that less than 11 per cent. of the nitrogen applied to the land in the form of sewage need escape in the effluent water, only a minute fraction of this being in the organic form; whilst upwards of 40 per cent. can be recovered in the crops grown on the land; a result which may be viewed as highly satisfactory, the quantity of nitrogen obtainable as crops from *solid* manure applied directly to land not amounting to more than 40 to 60 per cent. of that applied to the soil (LAWES and GILBERT). *British Association Reports, Brighton Meeting, p.* 135.

Nitrification of Vegetable Earth.—BOUSSINGAULT finds that the nitrogen of the atmosphere is not taken up during this process; he allowed vegetable soil mixed with sand and moistened to stand in a cellar for eleven years in sealed vessels; nitre was produced, but in quantity less than that corresponding to the quantity of nitrogen eliminated from the soil during this period. *Comptes Rendus*, 76, 22.

§ 6.—*Miscellaneous.*

Impervious Varnish.—The Chinese apply to chests of tea, tobacco, sugar, coffee, &c. a varnish made of freshly drawn blood, a little alum, and four parts of powdered slaked lime. One, two, or three coats of this mixture applied while viscid render the packages so impervious to moisture, that zinc foil, &c. becomes superfluous.—*Les Mondes, xxxi.* 142.

Manufacture of Bone Charcoal.—MALLET patents an improved set of retorts, condensers, &c. for this purpose. By means of a special adaptation, the residue in the retort can be incinerated in a current of air if necessary. The last traces of ammonia evolved are retained by an acid or a metallic salt. *Bulletin Soc. Chim. Paris, xx.* 90.

Paper from Wood-pulp.—It is asserted that paper made up of more or less wood-pulp is liable to become yellow-stained under the influence of light and heat. For books and other publications of a more expensive kind there should therefore be no wood-pulp paper used. *Bayer. Ind.- und Gew.-Blatt*, 1873, 74.

Tracing Paper.—C. PUSCHER recommends the use of castor-oil dissolved in three to four parts of absolute alcohol for rendering paper transparent. When the drawing, &c., has been produced on the sheet, the paper may be restored to its former character by washing out the oil with alcohol. *Bayer. Ind.- und Gew.-Blatt*, 1873, 30.

Tubes from Parchment-Paper.—The glue required for fastening the paper when it has been rolled into the tube-shape consists of a solution of isinglass, to which some potash bichromate has been added. Such tubes may be employed in the manufacture of sausages, &c. *Bayer. Ind.- und Gew.-Blatt*, 1873, 73.

Parchment Solution.—HOFFMANN recommends a solution of gutta-percha in ether as a very good varnish for maps, drawings, &c. The ether evaporates, and leaves a thin but strong film of gutta-percha on the sheet. *Chem. Centralbl.* 1873, 56.

Air-tight Corks.—F. RUSCHHAUPT soaks cork stoppers for a few minutes in molten paraffin, by which treatment the pores are filled up with the paraffin, and the pores thus rendered perfectly air-tight. *Bayer. Ind.- und Gew.-Blatt*, 1873, 72.

A Waterproof Glue.—A mixture of an aqueous solution of glue and of a similar solution of potash bichromate spread on paper, glass, &c. becomes on exposure to the light completely insoluble even in hot water. Such glue is therefore specially adapted for the use of articles which have to be washed or are otherwise exposed to water. *Bayer. Ind.- und Gew.-Blatt*, 1873, 73.

Preparation of a clear, easily drying Linseed Varnish.—L. GROMANN boils linseed-oil for about half an hour, adds to it, under constant stirring, a little manganese, which had previously been rubbed up to a syrup with some linseed-oil, and continues the boiling for an hour or an hour and a-half. After cooling and settling the clear portion is decanted off the sediment, and filled into bottles. For every twenty-five pounds of oil four ounces of manganese are required.

The bleaching of the varnish thus obtained is effected by exposing the bottles containing it to sun and moon shine. *Polyt. Centralbl.* 1872, 1629.

Functions of Atmospheric Nitrogen in the Growth of Plants.—DEHERAIN proves by a series of experiments that when certain organic matters are exposed to nitrogen or gases containing it, the nitrogen is absorbed or assimilated, being converted apparently into ammonia or some analogous body; humus-like products, such as exist in soil, cause this absorption tolerably readily, pure nitrogen being taken up more readily than nitrogen mixed with oxygen. Hence some clue may be gained to the explanation of the fact that the nitrogen removed from a given piece of ground in the form of crops is sometimes greater in amount than that present in the soil and the manure added; the humus, whilst decomposing, takes up nitrogen, forming black nitrogenous bodies, such as those recently studied by Thenard. Where the soil thus nitrogenized is exposed to the air by ploughing, a further decomposition ensues, whereby soluble nitrogenous matters capable of being directly assimilated by vegetation are produced. *Bull. Soc. Chim. Paris, xix.* 538.

Antidote for Mercurial Vapours.—MEYER states that mercurial poisoning may be entirely obviated amongst the workmen employed in mirror manufacture, &c. &c. by the simple process of impregnating overnight the air of the rooms with ammonia. The good effects of this process are so marked that men afflicted with mercurial palsy find their symptoms less acute and the attacks less frequent by continuing to work in the workshops thus protected. *Comptes Rendus, lxxvi.* 648.

Antagonistic Action of Physostigmine and Atropine.—The action of physostigmine on animal life may be counteracted by giving to the animal operated on a dose of atropine, either shortly before or after the physostigmine is exhibited; hence it results that the usually-received opinion that the injurious action of a poison received into the blood can only be terminated by the elimination of the poison is not strictly correct; in certain cases, at any rate, the toxic influence of a morbific agent may be directly opposed by a physiological antidote, and recovery may be produced by influencing the abnormal conditions themselves in such a manner as to cause their return to a normal state. *British Association Reports, Brighton Meeting, p.* 124.

Formation of Sugar in the Organism.—CLAUDE BERNARD publishes the results of many interesting physiological experiments bearing on this subject and on *diabetes*, natural and artificial. *Revue Scientifique, July*, 1873, *p.* 34.

Snake Poison.—BRUNTON and FAYRER have made a large number of observations and experiments on the nature and effects of snake poison; it thence appears that death is due to the action of the poison on the nerve-centres; but it is not yet decided whether this neurotic action is localized in the nerve-centres only, or whether there be, and if so to what extent, any action on other portions of the nerve apparatus. With large injections of poison, especially into a large vein, arrest of the heart's action, through a direct influence excited on the ganglia of the heart, may take place. With smaller doses a kind of zymotic blood-poisoning appears to be set up, especially in the cases of those varieties of snakes whose bites are less rapidly

fatal. A chemical examination of cobra poison by Armstrong indicates that it is a non-crystallizable nitrogenous substance, apparently of an albuminoid character ; alcohol partially precipitates it ; the part insoluble in alcohol is of nearly the same composition as the soluble part, but is much less energetic in its action. *Proceedings of the Royal Society, xxi.* 358.

On the Bitterness of Red Wines.—C. NEUBAUER has noticed that wines which had turned bitter (the cause of which has not yet been ascertained) exhibited at the same time a loss of colour and of tannic acid. The disease may be prevented by heating the wines to about 60° C. *Polyt. Centralbl.* 1872, 1630.

Preservation of Meat.—The proprietors of a large cotton-mill in Augsburg procure the meat required for their working people packed in salt from Antwerp, and treat it for better preservation with water and then smoke it in the usual way. The meat thus obtained is very wholesome, possesses a pleasant taste, and costs half the price of the fresh meat in Augsburg. *Bayer. Ind.- und Gew.-Blatt*, 1873, 71.

AMERICAN VIEW OF THE COAL QUESTION.

THE growing scarcity of gas coal in Europe is of vast importance to us, inasmuch as we are likely soon to monopolize the near markets, and this will yield to increased activity in our business relations with them. Not to speak of the countries on the Pacific, where, neither in China nor in Japan, nor in the Island of Formosa, nor in Australia or New Zealand, gas coal has been discovered, the field nearest at hand, Spanish America and the Brazils, is of vast importance to us already. The sudden rise in the value of certain products, especially coffee, hides, and copper, has during the past two years enriched all South and Central America ; and the people are launching out in local improvements and luxury on a scale only equalled by the lavishness of Cuban sugar planters ere the present insurrection broke out. Municipal and private establishments, such as we possess in our third-class cities, are becoming the order of the day in Spanish America and the Brazils. The people have the money and they mean to spend it. Private residences within the cities of those countries mostly originate from the times of the old viceroyalties ; they are tall, majestic piles of masonry, built on a liberal plan, with the Moorish *patio*, or court-yard, uncovered in the middle, and to light the vast apartments a great deal more gas is consumed than in American private residences on a like scale. Their streets and public squares are on the same spacious plan, and so are the theatres. Hence, the consumption of gas *per capita* in a Spanish-American city of the first or second rank is about three times what it is in an American city of the same size, the more so as social intercourse is a great deal more animated after sunset in those warm latitudes than what it is the year through in the generality of our States. This will suffice to show the importance of the new customers we shall have to supply henceforward and alone. The railroads leading to tidewater from the coal regions will, of course, reap the benefit from this sudden increase of business relations, the more so as our next-door neighbours have commenced to use our ordinary coal also in large quantities for the past six or eight months, Canada vieing with us in supplying them, yet a goodly portion falling to our share. It is to be presumed, therefore, that more than ever we shall be canvassing the localities whence all this coal for gas purposes is to be drawn, and unless we are able to extract it fast enough to meet requirements, the inference is that such coal, now commanding the moderate figure of 9 dollars per ton, will in the course of time attain a considerably higher market value. *Apropos* to this important crisis in the coal trade, we have the prospect of an inexhaustible supply being made at once available by the opening of the Chesapeake and Ohio Railroad. That line runs through the heart of a coal and iron field, which in its extent, its richness and its variety of these minerals is probably unequalled by anything yet discovered in any part of the world. Its supply of gas coal is inexhaustible ; and experiment has demonstrated that its yield of gas is equal to that of the best English coal. These deposits lie on the route of direct water communication *viâ* the Ohio and the Mississippi to the Gulf of Mexico, and are within a moderate distance, *viâ* the Chesapeake and Ohio road, of the Chesapeake Bay, thus having the advantage of the shortest possible routes to the West Indies and to Central and South America. It seems inevitable that this must become the great source of coal supply to countries which have hitherto drawn their gas coal almost entirely from Great Britain. This prospect is encouraging, not only to an important railroad enterprise and to an hitherto neglected mineral region, but also to our mercantile marine, long in a state of decadence. Our great difficulty hitherto in contending for the carrying trade of the West Indies and South America has been that vessels going thither from our ports could not find paying outward freights ; but with a constant outflow of coal, and possibly also of manufactured iron (for the two are apt to keep close company), this difficulty would be obviated, and, with the distance in our favour, there seems to be no reason why we should not, under the changed conditions which seem to be in process of evolution, control within a few years this very important branch of the ocean carrying trade. Thus the causes are already beginning to work, which must before long transfer the commerce of the Antilles and of Central and South America from Europe to the United States.—*New York Bulletin.*

THE GREAT BALLOON FOR CROSSING THE ATLANTIC.[1]

THE following particulars concerning the new balloon of Professor Wise will be interesting to many of our readers :—

The main balloon is to be made of unbleached cotton, of which 4,316 yards have been purchased. The greatest strength is required at the crown, and this part of the air ship will have three thicknesses of cloth. The exterior will be coated with a varnish made of linseed oil, beeswax, and benzine. The balloon is to be 110 feet high, and 100 feet in diameter. Gas capacity, 600,000 cubic feet. It will, however, start with only 400,000 cubic feet, as the gas will expand and fill the balloon as the latter rises in the air. When inflated, the extreme height of the apparatus, from the crown to the heel of the boat, which will hang below, will be 160 feet. There will be 14,000 yards (eight miles) of stitching. The thread used is silk and cotton, the top spool being silk. The valve of the balloon will be three feet in diameter and made of Spanish cedar, with a rubber-coated clapper closing on a brass plate.

The network will be composed of three-strand tarred rope, known as "marlin." The width of the net will be 212 meshes, and its breaking strength will be 58,300 pounds. Five hundred pounds of "marlin" will be used. From the netting 53 ropes, $\frac{5}{8}$ inch in diameter, of Manilla, will connect with the concentrating rings. These ropes will each be 90 feet in length, or 4,770 feet in the aggregate. The concentrating rings will be three in number, to guard against breakage, and will be each fourteen inches in diameter, each ring being of wood, iron bound. These rings will sustain the car, lifeboat, and trailing rope, and will bear the strain when the anchor is thrown out in landing. From the concentrating rings, twenty-four Manilla 1-inch ropes, each 22 feet long, or requiring 528 feet in all, will depend, and form the frames for an octagonal-shaped car. They will be kept in place by light hoops made of ash. The lower ropes will be connected with network, and over the network at the bottom of the car a light pine floor will be laid loosely, so that it can be thrown out if required. The car will be covered with duck, of which fifty yards will be needed. Attached to the side of the car will be a light iron windlass, from which the boat and trail rope can be raised and lowered as may be desired. From a pulley attached to the concentrating rings a heavy Manilla rope will fall down through the car, and thence to a sling, attached to which will be the life-boat. This boat will be of the most approved and careful construction. It will have watertight compartments, sliding keel, and will be so made that it will be self-righting. The boat will be provided with a complete outfit of oars and sails, and to it will be lashed instruments, guns, lines, &c., and provisions for thirty days, all in watertight cases.

The trial rope, by which the aeronaut can maintain any desired altitude without resorting to ballast, will be of Manilla rope, $1\frac{1}{4}$ inches thick, and 1,000 feet long.

The car will be fully provided with instruments, provisions, &c., independently of the boat. It will be so constructed that it can be taken apart piecemeal and disposed of as ballast. It will carry about 5,000 pounds of ballast, which will consist of bags of sand, each carefully weighed and marked. Among the instruments to be carried in the car there will be a galvanic battery with an alarum, two barometers, two chronometer watches, a compound thermometer, a wet and dry bulb thermometer, a hygrometer, componer, quadrant, chart, parachutes with fireballs attached, and so arranged as to explode when striking the

[1] From the "Scientific American."

water, so as to indicate the direction traversed; marine glasses, two vacuum tubes, a lime stove, &c. A number of carrier pigeons will be taken along, and dispatched at intervals on the route, with intelligence of the progress of the expedition.

The lifting power of illuminating gas is about 36 pounds to the 1,000 feet, so that the balloon will have a lifting capacity of 11,600 pounds. The pressure will be 1½ pounds to the square inch.

The weight may be summed up as follows :—

	Pounds.
Balloon	4,000
Net and ropes	800
Car	100
Boat	1,000
Dray rope	600
Anchor and grapnels	300
Sundries	300
	7,100

Then 4,500 pounds will be allowed for passengers and ballast.

IMPROVED SELF-ACTING FIRE-TANK.[1]

THE alarming frequency of fires within the last few months has awakened an unusual interest and provoked a deal of newspaper discussion as to the best means for the prevention and extinguishment of conflagrations. The lesson of the Boston fire is one that has often been pointed out, but seldom heeded, namely, that when a fire has reached a certain stage, it gets beyond the control of any apparatus whatever, and takes, for the most part, its own course. Any improvement in our present systems should be in the direction of a greater promptitude in extinguishing incipient fires before they reach the dangerous stage.

The point aimed at in the construction of apparatus heretofore has been the projection of the largest possible bulk of water upon the fire. The result has been an enormous increase in the item of water damage, without a proportionate gain in the celerity of action which is the real element of success at fires.

Considerable attention has been given, within the last few years, to the perfecting of devices which should take advantage of the extinguishing properties of carbonic acid gas. This material seemed to promise the condensed power requisite to portability in the transportation, with the utmost expedition in generating pressure and manipulation, while possessing the additional recommendation of quenching fire without water damage. Coupled with these advantages, there seemed to be a certainty of action and a marvellous power over flame unattainable by any other known method.

The only system in which this principle has been made practical is that in which chemical action is used, not only to impregnate the stream with the desired extinguishing quality, but also to propel it, and in which water is used to dissolve the chemicals, to hold the gas in mechanical combination, and to give momentum to the projected stream.

The small machines called "extinguishers," which combine the points enumerated, have made a splendid record, and in scores of instances have put out fires that were apparently out of all proportion to the means used. The limit of the extinguisher is in its capacity. As the operator must carry on his back the engine, hose and material, the weight is restricted to 85 lbs., and the stream to a diameter of one eighth of an inch and a duration of perhaps five minutes. The principle was perfect, but its full development seemed to call for a continuous stream of such volume as would control a fire in the more advanced stages. The first practical success in this direction is found in the street engine of the Babcock Fire Extinguisher Company. The engine is constructed with two copper tanks of a capacity of 120 gallons, tested to a pressure of 500 lbs., and mounted on wheels. The hose is connected and ready for instant action, and the stream, of thirty times the volume of that of the "portable," is thrown 100 feet from the nozzle. On arriving at a fire, a pressure of 200 lbs. is raised in ten seconds, and so ready is the manipulation that the stream is on the fire in less than a minute. This celerity of action is due not merely to the instantaneous generation of pressure, but to the fact that no suction hose has to be connected, and no leading hose laid preparatory to playing. The result of this promptitude, together with the marvellous extinguishing power of the stream, is, in a large proportion of instances, the putting out of the fire before it is fairly started. Statistics prove that fires are, eight times in ten, discovered in the earliest stage, and the fate of the building is usually decided by the action of the first five minutes.

Thus far the engine has been introduced into the departments of some fifty cities and towns, and has already made a history such as no other apparatus has ever approached. At Chicago the engine puts out fifty per cent. of the fires within its range, without the aid of the steamers. The mayor, in a late communication to the fire commissioners, recommends the purchase of fourteen more of these engines for the department at a cost of 2,000 dollars each. At Boston, the single engine that was ordered since the fire there has been in the department two weeks, during which time it has put out four fires in advance of the steamers, and has made so favourable an impression that the chief engineer recommends the purchase of four more. At Holyoke, Mass. the engine extinguished thirteen fires out of the nineteen that have occurred in the last two years, before the steamers could get a stream on. At many of these fires the engine has shown an efficiency little short of the miraculous.

Every town that is supplied with these engines has reduced its fire and water losses materially, generally to less than fifty per cent. of the average before its adoption. At Holyoke the loss at three fires, in the five months previous to its introduction, was 375,000 dollars. During the remainder of the same year (seven months), the loss in six fires was 1,665 dollars. In nearly every instance the first building is saved, and often almost without damage. A still more astonishing claim is, that out of 300 fires heard from, in only three cases has a second (detached) building burned. At Westfield, Mass. the engine handled four fires at once, and saved all the buildings. It has been used under every variety of circumstance, and has never failed to throw its stream.

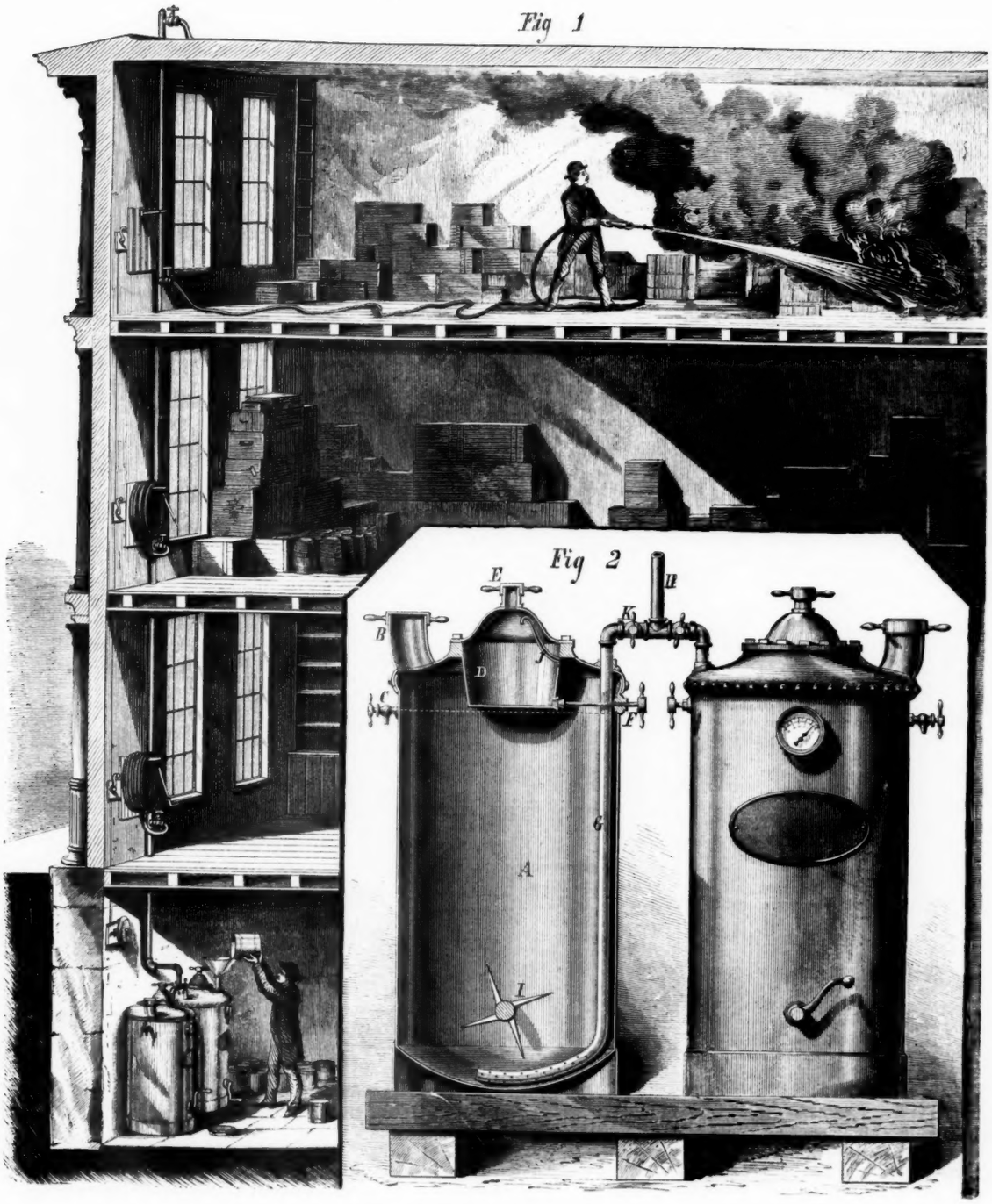
The wonderful success of the forms mentioned has led the company to the development of the same general principle in a form particularly adapted to the protection of the interior of large buildings, factories, theatres, sailing vessels, &c. By reference to the accompanying illustration, the construction of the apparatus will be readily understood.

A is one of a pair of tanks holding from 50 to 100 gallons each, and filled with soda solution to the level of the gauge cock C, through the opening B. D is the acid chamber which is filled through the opening E, and discharged by the valve F. On discharging the acid the pressure is shown by the pressure gauge, and on opening the gate K, the stream flows up through the exhaust pipe G, into the main H, finding vent through the hose on every floor where a cock is opened. The agitator I is for stirring the fluid to facilitate the dissolving of the soda in re-charging. The practical working is admirably illustrated by the picture in the background, and will be comprehended at once. The plan is virtually the same as was lately presented before the Polytechnic Association, by Mr. D. J. Tapley, where it attracted much attention.

The peculiar advantage of this form is that it gives an instantaneous stream of a sufficient volume to control any fire that can be built in an ordinary interior. In theatres and churches it will throw a stream to the highest part of the ceiling, and even from the roof a stream can be used to protect from fires in adjoining buildings. The power of the tanks is sufficient to force a stream through 300 feet of perpendicular pipe, or any length of horizontal hose or pipe. The stream seems to possess the wonderful property of clearing a room of smoke almost instantly, though filled to suffocation. The gas also seems to interpose a wall of non-conducting vapour between the hoseman and the fire, which protects him from the heat. In fact, experience is developing every day new advantages for this system.

[1] From the "Scientific American."

HYDROCHLORIC Acid for Chapped Hands.—G. C. Close. (*Proc. Amer. Pharm. Assoc.* 1871, 489.) The author states that he has recommended a mixture of one or two drachms of hydrochloric acid to four ounces of water for use in cases of chapped hands, and even when the skin was cracked and bleeding, he has no recollection of its failure to relieve the complaint at once, and if persevered in, to effect a cure.



THE BABCOCK SELF-ACTING FIRE TANK.

PREMATURE DECAY OF TIMBER.[1]

(Suggested by an Examination of the Wreck of the late Steam Frigate Chattanooga.)

By Hector Orr, Member of the Institute.

Read before the Institute, Nov. 22, 1872.

WE are generally aware of the building and equipment of the frigate Chattanooga at this port about the close of the late war. We also know that this vessel was injured by the ice and partially sank off League Island last winter. During the summer just passed she was sold as a wreck and bought by Mr. Alexander Purves, long known in the iron trade of this city, and who is an active member of the institute and also of its meteorological section. At a meeting of this section I inquired of Mr. P. concerning this wreck, and to his politeness I am indebted for the opportunity of examining the same and presenting these few thoughts thereon to the institute.

I found this vessel (or at least her hull) lying on the flats above Gloucester City on the New Jersey shore. Her length over all was 350 ft., with a keel alone of 300 ft. Her outfit embraced a three-blade propeller 18 ft. in diameter, of tough compound metal, and a powerful steam-engine of Merrick's best workmanship.

All the machinery had been removed and the work of demolition had begun both fore and aft from the bulwarks downward; but the great mass of her bulk was there. The amount of "dead wood" presented at the bow and stern was enormous. The stern, as the seat of the propeller, required an extra mass, and the bow seemed intended to act the part of a naval "ram." The "ribs" or timbers were but a few inches apart, and had chock-braces at every few feet, and amidships, diagonal wrought-iron straps were placed in abundance across the timbers.

All the just constituents of a noble ship seemed to be there, and each in its right place; but in all this structure there was scarcely a sound piece of wood six feet long! White pine, yellow pine or oak—ribs, planking, lining or deck—all were smitten as with a common plague, presenting a mass of rottenness which crumbled at your tread, nay, even at your touch!

Less than eight years ago the keel of this ship was laid. She scarcely left the waters of the Delaware, never threw a broadside or saw an enemy. The Rebellion waned as she grew into shape, and expired almost at the first movement of her engine. Thus far she had a happy history—that of her remaining life is far different.

Mr. Purves has dealt with other wrecks of various dates of life and service, and in his company I met experienced seamen and ship-carpenters, and they all unite in saying that they never saw the like of this! Numerous specimens of this wreck will be found on our table, marked as to position and kind of wood, taken from the kelson upwards. Near the forward bends the timbers were *doubled*. I noted one or more instances in which a pine log and an oak log were thus coupled, and the decay had evidently begun at the inner surfaces, which were in direct contact with each other; but even where both logs were of the same wood the same inward decay appeared. Whether in the undisturbed mass, or where pierced with iron or copper fastenings, or even with the humble treenail, the fibre was completely broken up.

My friend Dr. Reynell Coates has reminded me that the fleet of Commodore Perry, which was built in haste from timber cut on the lake shore for service in the war of 1812, suffered from early rot, so that the vessels were pronounced unseaworthy soon after the peace of 1815.

Also, Mr. Purves assures me that he has known a strange tendency to decay in some vessels, indicating a sort of triennial crisis in their early life, which, if passed without injury to the wood, predicted some twenty-five years of wear. It is somewhat analogous to the test of the third summer in children. I do not insist on the analogy, but we may recollect that out of such unpretentious facts as we are here recording, Newton and Franklin started their wonderful discoveries.

I have learned from Mr. Durfee (superintendent of the Midvale Steel Works) that he has witnessed a few marked instances of decay in large pieces of timber, such as pillars, girders and even rafters, that were *cased* in light boards to improve the appearance of the room, the inner mass being found dangerously rotten. And here I will take the liberty to say that I have for full forty years watched the not very graceful deflection of our girders in the ceiling above us, and I think that it may be worth while to test their internal solidity at some convenient season not far distant. If we let this hint come "home to our business" now, it may prevent its coming "home to our bosoms" unpleasantly eventually.

Mr. Purves has further noted the decay of wood on shipboard under circumstances which seem to me quite worthy of attention: On portions of the "lining" of vessels covered with zinc or tin, as in provision closets, &c. the decay followed exactly the surface covered by the metal, indicating the action of "dead air" in contrast with that of a free atmosphere on the surrounding parts which remained sound.

The observations of both the gentlemen last quoted point to a state of things very similar existing between the timbers of the Chattanooga, enclosed by planking outside and by the lining or ceiling inside—chambers for dead air were thus formed throughout the entire hull; and the other testimony kindly offered me by others I hope may tend to give us the clue to avoid in future the sad result which furnishes the title to these remarks.

I have already alluded to the short duration of our war navy on the lakes. Its vessels were built in haste for a pressing emergency. The same is true of the Chattanooga; but nearly sixty years have passed since Perry's victory; and what years of progress have they been! In them have arisen the ocean steamship, the locomotive, and the railway, the telegraph, and the "Franklin Institute." We have had various processes brought out in this period for the preservation and speedy seasoning of wood. I could not name them all, much less describe them; I will mention one, however, which seemed to me worthy of attention from its simplicity and apparent effectiveness. It is perhaps fifteen years since my friend, Mordecai R. Moore, late member of our City Council, made known to me what he considered a valuable improvement in the seasoning of timber. I am not sure that the invention was patented. It was not invented by Mr. Moore, but he was persuaded of its value. The process consisted in charging the freshly-cut wood with superheated steam for a period of twenty-four hours; then by powerful apparatus exhausting all fluid from the fibre, and charging it anew with dry and highly-heated air for another twenty-four hours; and on the third day the wood was ready for use.

Like too many of the group, which seems but a few at best, Mr. Moore is dead; and thus far I have not been able to trace up this invention in present hands. Even if it was patented, its date must be out by this time; but the process certainly ought not to be forgotten. If this marvellous decay which I am relating to you is due to the haste with which the work had to be done, surely this two days' process would not have delayed it much; and look at the consequences! In the condition in which Mr. Purves took possession of this vessel, she had hardly the strength of a partition of lath. She sank before the ice last winter, because her empty bulk was too much for her strength even in the placid waters of the Delaware. In her first storm at sea she would have been but a ready-made coffin of unusual shape to all on board.

There is still another consideration which I will present here, as to the hygienic condition of such a structure. Some seventeen years ago, our venerable and excellent citizen, Dr. René La Roche, set himself to write the history of the yellow fever. It is in two thick volumes 8vo., and I read the "proof" of its pages. It embraces piles of conflicting testimony, but at least one definite conclusion was attained, to this effect—that in all well ascertained centres of production and diffusion of said disease, three conditions were always present, namely, heat, moisture and decayed wood. Now, mark this: I am quoting from a work at least seventeen years old, yet follow me aboard this unfortunate vessel for a few minutes, and see how it applies there. As to moisture, her mere bilge water would furnish this, even without the dripping from tanks and boilers; the heat is insured by her furnaces, which a cruise in the tropics would aggravate, and surely the rotten wood was there at once in profusion and perfection. Ponder the fate of this ship's company; danger without and covert, lurking death within—around poor Jack's humble hammock and in his very nostrils.

And to show you that I am not drawing upon fiction, our observant actuary informed me, a few days ago, that one of our physicians had actually detected a well-marked disease on board this very vessel.

Mr. President, I have no special personal interest in this case of our abandoned frigate, and surely take no pleasure in this recital. But we participated in the fame of the noble ships which for a hundred years have been built here, and we must share in the shame of this one.

I will close with the hope that we may never see such another war as the one we have happily closed, nor such another warship as the one I have just examined!

[1] From the "Journal of the Franklin Institute."

DISCUSSION.

Mr. CLOSE rose to correct a portion of the statement in Mr. Orr's paper as to the Chattanooga never having left the waters of the Delaware river. Mr. C. went on to state that the contract required the ship to have a trial at sea, the wheels to be turned a certain number of times, and consume a certain quantity of coal in a given time, and under the supervision of Mr. Zeller, the chief engineer, the test was accomplished, the ship being at sea three days.

And as to the decay of the wood, Mr. C. went on to state that at the time the ship was building no yellow pine timber of good quality could be obtained (during the Rebellion), and a substitute had to be made of the Bastard or Norway pine, then growing in North-western Pennsylvania, which has little or no traces of the resinous material found in the yellow pine grown in the Southern States; in fact, an expert will tell within fifty miles of the latitude where a certain piece of yellow pine grew, if shown to him. The decay commenced in the sap of the Norway pine, caused by want of ventilation, which disease was communicated to the oak frame by contact and want of ventilation. Woods that have been preserved under water on the Kensington side of the Delaware river have been laid on the ground at Petty's Island and rotted to spunk or earth in one year, while the same wood laid on the ground on Kensington side showed no signs of decay after remaining several years exposed.

Mr. C., on being questioned as to the time of year of the cutting of the timber having something to do with the decay, he stated that that theory was approved by workers of timber, but he had very little faith in it.

Mr. ORR gave pointed attention to the remarks of Mr. Close, and then rejoined that he certainly had understood from Mr. Purves that the vessel had never gone to sea. He was rather incredulous still as to the actual length of her longest voyage. All the other explanations of Mr. C. confirmed Mr. Orr's specifications. He inquired of Mr. Close if he was acquainted with the "seasoning" process of Mr. Moore, which had been described, and on Mr. C. disclaiming any knowledge of the same, Mr. O. ended his response by saying he was glad to learn that the Chattanooga had gone far enough to get her worthy contractors their pay, which he believed was the only good thing done by said vessel.

Mr. DURFEE said his knowledge bearing on the immediate subject under discussion related mainly to the case of a church of quite recent erection, whose rafters or roof timbers had been enclosed in attractive casings to give finish to the interior, and upon occasion arising for the application of nails to said ceiling, at the single stroke of the hammer the nail penetrated to its head, the inner wood being quite destroyed.

Mr. CLOSE recollected a very similar case in a roof where the enclosed wood was reduced to comparative powder.

The treasurer of the institute, Mr. FREDERICK FRAYLEY (who had already reported a series of obituary resolutions on the death of Prof. Frazer, and given an extended extempore address on the lamented Mr. Agnew), rose and apologized for again taking the floor, but urged the importance of the subject as his excuse. After alluding, parenthetically, to the severe loss by fires within the past twelve months, especially in Chicago and Boston, and inviting the attention of the institute to the devising of additional means for meeting and preventing such calamity—went on to state his experience in shipbuilding in the unpretentious item of canal boats, in whose structure his company had been induced to dispense with the inner covering (or ceiling), and by a strong outer planking carefully joined and caulked, the inner surface of the ribs was left bare, with a decidedly improved result on the endurance of the wood, proving the valuable effect of free circulation of air and the action of light also in such instances.

The President (Mr. C. SELLERS) also offered further testimony condemnatory of the practice of insulating wood from the action of light and free air. In his own house (of comparatively late construction), he accidentally detected a serious defection in his principal floor—the ends of its joists being almost uniformly rotted off even with the wall in which they had been inserted; while in a very old family building (viz. that of his grandfather), the joists were found to be uninjured; but said joists presented their ends to the air, which had free access to their surface.

Mr. ORR rose, by permission, to call attention to the remarkably uniform tendency of the testimony volunteered as to the evil of enclosed timbers, and he was afraid that it leaned too much in one direction. He appealed to Mr. Frayley's recollection of Cope's first line of packet ships, built by good Robert Burton on an average of fifty years ago. Those ships ran regularly for twenty-five years on said line and then were sold as whalers, and were perhaps still afloat. The present Tuscarora (the second of the name) was still a model of strength and beauty, though once struck by an iceberg full twenty years ago, and again having the misfortune to lie aground near Cape Henlopen through a part of a winter. Yet all these ships were built with enclosed timbers, planked and ceiled, on the very plan which we now seemed ready to condemn! He wished the subject to be looked at, not only on both sides but all around. He had met some bluff specimens of artists on board the wreck, who vowed their belief that "wood growed different now from that cut long ago." He had thought much on this terrible decay of wood, both in ships and bridges and in street pavement, and hoped members would take the consideration of the matter home with them.

Mr. FRAYLEY fully endorsed Mr. Orr's description of those noble ships of other days, and admitted their strange contradiction of our present experience in this department of mechanics. He wished to call attention to one more fact on the general subject—that at the dates to which Mr. Orr referred it was the practice of Philadelphia shipbuilders to apply coarse salt between the timbers of the best ships.

THE PRACTICAL NOTE-BOOK OF TECHNICAL INFORMATION USEFUL TO STUDENTS AND WORKMEN.

(51.)

THE Elements of Iron Construction.—In note No. 50 we gave remarks and diagrams connected with rivets and the riveting of plates of iron; in resuming the subject we now illustrate the use of "angle" and "T" iron in this practice. In fig. 211 we give at *a a a* a cross section of angle iron, and at *b b b' b'* elevation of same. The same figure also illustrates the method of joining or fishing two pieces of angle iron *b b b*, and *b' b' b'* of the section as shown at *a a a*, by the use of a fishing piece *c c c* in section, *d d d* in elevation; the two being secured together by the rivets *e e* in elevation, and *f* in section. The fishing piece *d d* extends an equal distance on each side of the joint of the two pieces *b b b*, *b b' b'*, the joint being shown by the dotted line *g g*. In fig. 212 we illustrate a form of "T" iron, other sections of which will be shown in the illustration of roofs as yet to be given. Fig. 213 illustrates a method of joining two plates of iron *a a*, *b b*, the butting joint *c* of which is shown in section by means of two lengths of "T" iron *d d*, *e e*, the whole secured together by means of rivets *f* and *g*, a line of these being placed on each side of the central rib of the "T" iron. In figs. 214 to 217 inclusive, we give illustrations showing the method of joining a plate of wrought-iron at right angles to cover another plate, thus ⊤ Fig. 214 shows the front elevation of a wrought-iron plate *a a*, stretching from left to right, and *b b* the plate in section, projecting from the face of this at right angles. The plate *b b*, as will be observed, projects a little above the line of top of the plate *a a*, the use of which will be hereafter explained. The angle irons *c c d d* are placed one on each side of the central plate *b b;* the one plate or wing of the angle iron, as *c c*, being secured to the plate *a a a a* by lines of rivets *e e e e*, and the other plate *d d* of the angle irons joined to the central plate *b b* by the line of rivets *f f*, *g g*. To further strengthen the arrangement and prevent buckling, the strengthening plate *j j* is placed at right angles to *a a*, *a a*, and of course running in a line with and along the top of the plate *b b*, which is lengthened as above stated, and on the upper edge of which the plate *j j* rests. The plate *j j* is secured to the central plate *b b* by the angle irons *i i i i*. These and the plate *j j* are first secured to the central plate *b b;* and thereafter the angle irons *c, c, d d* are secured to the plate *b b* and the plate *a a*, the upper ends of the angle irons being bent, as shown at *c' c'*, in order to clear and at the same time to embrace the lower wings of the angle irons *c c c c*. Fig. 215 gives a side elevation of the same, in which of course the position of the plates *a a a a* and *b b* are changed with relation to the draughtsman—the plate *a a* now being in section and presenting its edge, the plate *b b* being in elevation; the same letters indicate corresponding parts. As we are desirous that the student should thoroughly understand the different relations which the plates have to one another, we give two other views of the arrangement of plates in figs. 214 and 215, fig. 216 being a section on the dotted line in fig. 214, the draughtsman being supposed to be looking in the direction of the arrows, the arrangement of plates

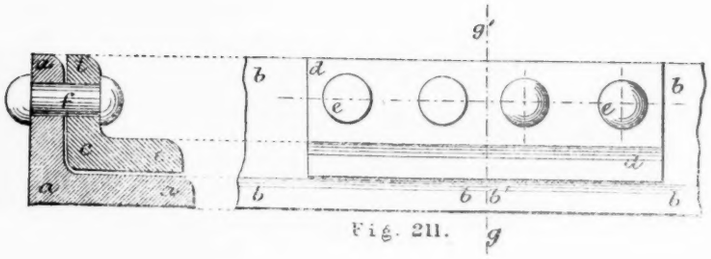


Fig. 211.

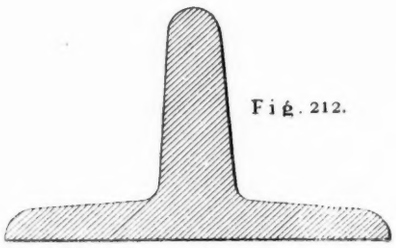


Fig. 212.

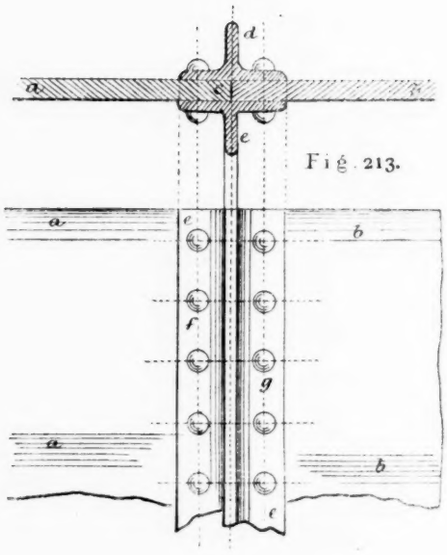


Fig. 213.

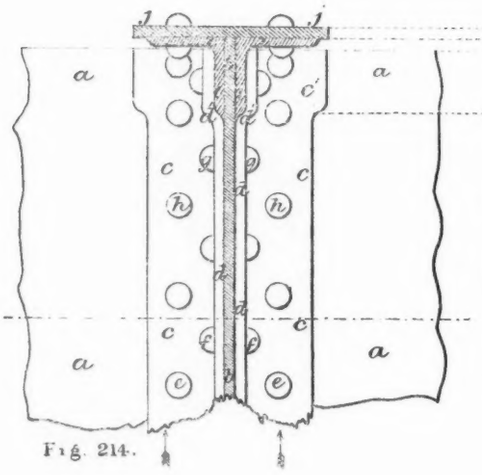


Fig. 214.

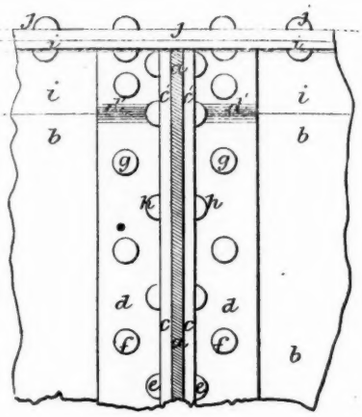
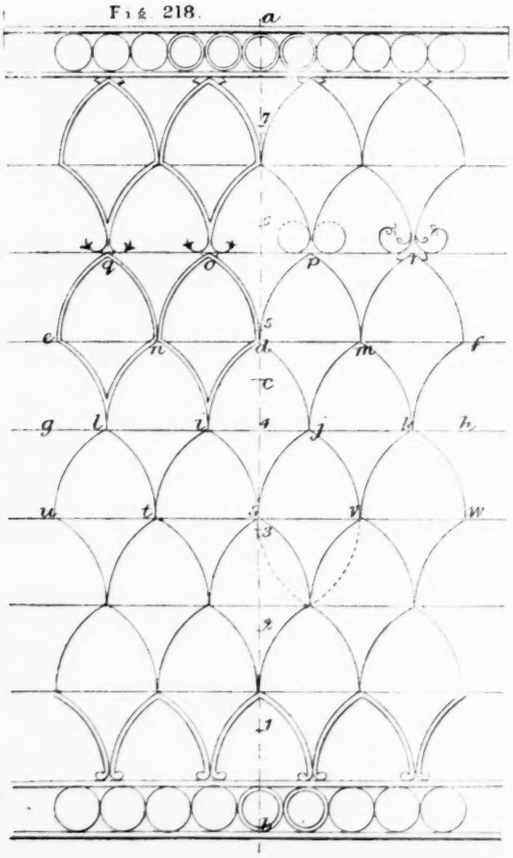


Fig. 215.

Fig. 218.



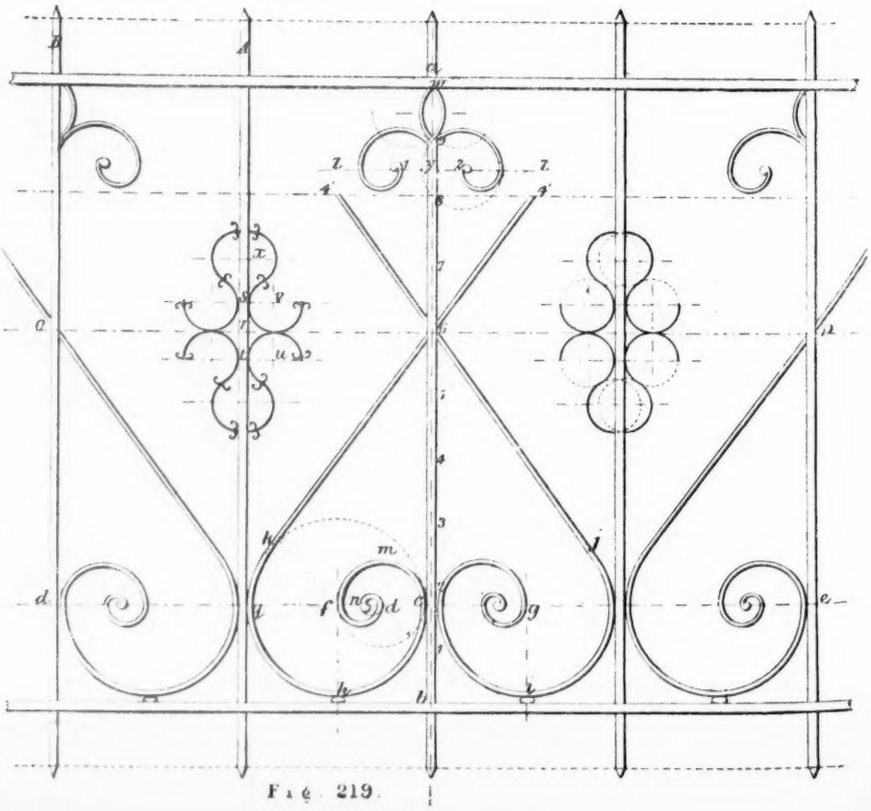


Fig. 219.

in fig. 214 resting upon the top of the plate *j j;* so that he looks down upon the inner side of same, showing the plate *b b* running along as in fig. 216, with the angle irons *i i* on each side of it, and the plate *a a* in section at the end of it. Fig. 217 gives a plan of top of the plate *j j* looking down upon its length in the direction of the curve *c*, fig. 214. In all the diagrams the same letters show corresponding parts. In plate work the connection of the different parts give a certain degree of complication to the drawings, so that it will be well for the student to master the arrangement of the elementary forms before proceeding to the study of regular beam work.

Sub-section.—Ornamental Iron Work.—In fig. 218 we give

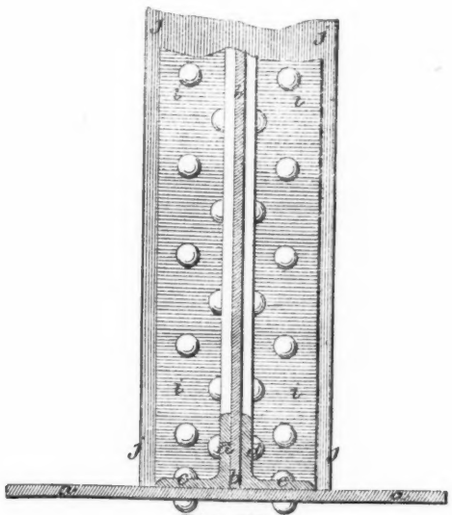


Fig. 216

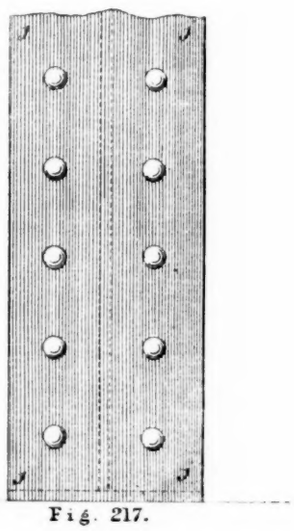
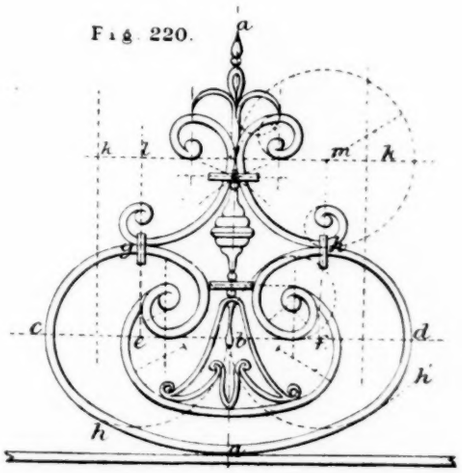


Fig. 217.

an illustration of wrought-iron railing work of a simple design. Let *a b* be the height; divide this into seven equal parts. Divide the space between 4 and 5 into two equal parts in the point *c;* divide *c* 4 into three equal parts; from the point 5 set down one of these parts to the point *d*, and through *d* at right angles to *a b* draw the line *e f*. Through the point 4 draw a line parallel to *e f*, as *g h*. From the point 4 set off the distance 4 *c*, on each side of the centre line *a b*, to the points *i* and *j*. From these points as centres, with *i d* or *i j* as radii, describe arcs cutting in the point *d*. From the points *j k i l* as centres, with same radius (*i j*), describe arcs meeting in the points *m* and *d*. These arcs may be described to any number on the line (*g h*) produced. From the points *d e n m f* as centres, with radius *i j*, describe arcs cutting in the points *o*, *p*, *q* and *r*. Through the point *s* draw a line parallel to *g h*, the point *s* being equal in distance from the point 4 to 4 *d*. Then from the point *s* with the distance *i j*, set off on either side of centre line to the points *t u v* and *w*. These will be the centres of the arcs meeting in the points *l i j k*. The leading lines of the design being thus obtained, the parts may be finished as in the drawing. In fig. 219 we give a design of a simple character for wrought-iron balustrade or railing work, in which *a b* is the height, which is to be divided into ten equal parts. Divide the distance between the points 1 and 2 on the line *b a* into three equal parts, and through the first of these from 2 on *c*, draw at right angles to the line *a b* the line *d e*. Make the middle rail, as *a b*, of a width equal to half of one of the parts on 1 2. From the point *c*, with the distance *c b*, set off on the line *d e* to the points *f* and *g*, and from these draw lines parallel to *a b*, to *h* and *i*. Then from the points *g* and *f* describe arcs which touch the middle rail on each side, and the points *h* and *i*—and from the same centres describe arcs *i j* and *h k;* then terminating as at the lines *g j*, *f k*, which are drawn into an angle of 45° to the line *f g*. The space between *f* and *c* is divided into two equal parts in the point *l*, which is the centre of the arc *f m c*. The next centre is at *n*. Through the point 6 on the line *a b* draw a line *o p*. From *f* make *f q* equal to *f c*, and through *q* draw a line *q r* parallel to *a b*, which is the inside line of the second vertical bar. With the distance of one and a third of the parts on 1 2, set off from *r* to *s* and *t;* and through these draw lines at right angles to *a b;* make *t u*, *s v* each equal to *r s*, and *v* and *u* will be the centres of the arcs as shown; *x* is the centre of the arc which, described with the same radius, joins that described from *v*. Divide the distance between the points 8 and 9 on *a b* into two equal parts in *y*, and through *y* draw *z z* parallel to *d e;* on this set off the distance *y'*, equal to *s v*, this will be the centre of the arc 92' *z*. The centre of the arc *z* 1 is at 3. A line 4' 4' is drawn parallel to *d e*, touching the curves as 3'. From the point 8 with distance *b c*, set off on this line to the points 4' 4', 5', and join *k* 4', *j* 4'. Finish as in the drawing.

In fig. 220 we give a design for a central ornament forming the finish of a rail or balustrade, as, for example, filling up the part between the two rails (A and B) in preceding figure. Let *a a'* be the centre line, and *a b* the distance from top of upper rail to the centre of the lower part of the design; through *b* draw the line *c d* at right angles to *a b; c d* is the length of the lower part of the design. Divide *c b*, *b d* into two equal parts in the points *e* and *f*. From the points *e* and *f*, with radius *e c*, describe the circles as *g c h*. From *e* and *f*, with radius *e f*, describe an arc cutting in

Fig. 220.



the point *i;* from *i* with *i a*, describe the arc *b a k'*. From the point *b* set off the distance *e f* to the point *j;* and through *j* draw a line *k k* parallel to *c d*. From *j* with the distance *b f*, set off to the points *l* and *m*, and these will be the centres of arcs forming the upper part of the design. The lines and centres for the spiral termination of the leading curves thus described are shown in the drawing. In fig. 221 we give a design for a central ornament, with the lines and centres shown, the leading distances being parts of the divisions made in the diameter *a b*, as the parts *c e d*. In figs. 222, 223, and 224, we give suggestions for various forms useful in designing ornamental ironwork, the lines and centres being given on each diagram.

(52.) **New and Simple Method of delineating Square-Threaded Screws.**—In note No. 37, p. 384, vol. i. the reader will find a description of the usual method adopted for delineating a square-threaded screw with a given pitch and diameter; this, although it gives the correct outline, is, as will be found by those who have gone through the operation there described, tedious, and to the inexperienced draughtsman somewhat difficult. In the "Scientific American" a correspondent gave some time ago a method which possesses at least the advantage of simplicity, and is claimed to be correct. It is based upon the principle that the form of the screw is that of a parabola. "All bodies," says the correspondent, Mr. T. B. Killogg,

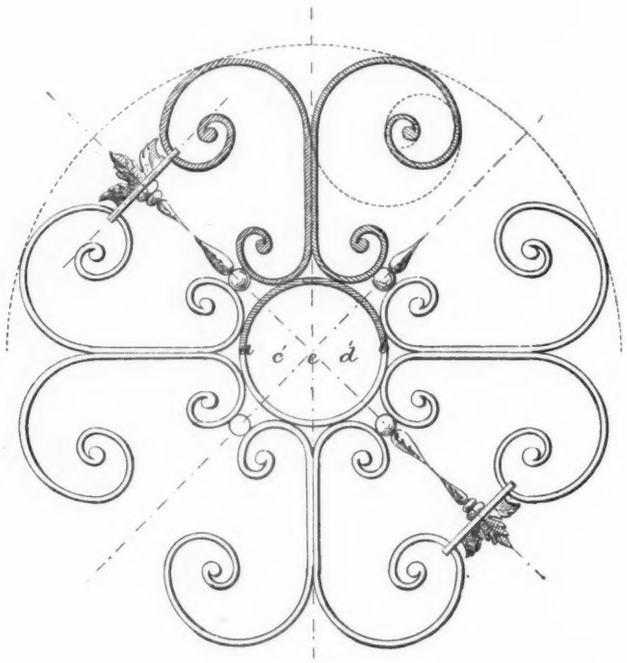


Fig. 221.

"thrown into the air, out of a line perpendicular to the earth's surface, describe parabolas. In cutting a screw the force moving the tool corresponds to gravity; that of the screw to projectile force; the resultant of these two forces, when seen in a line perpendicular to the centre of motion, is a parabola." In figs. 225, 226, this principle is exemplified, the perspective outline of the square-threaded screw, part of which is shown at the line *a b c d*, being drawn by following the outline of a parabola of which the base, *e f*, is equal to half the pitch, *j m*, of the screw; and the height, *h i*, equal to the diameter, *j c*. By describing the parabola, *f h e i*, on a piece of thick cardboard, and cutting it out carefully by the outline, a small template may be made by which the outlines of the thread of the screw may be drawn. We have prepared illustrations based upon those of the correspondent alluded to, but in a manner which may possibly make the application of the principle more easily understood than that given by him. Draw the centre line *j k* of the screw, and on it mark the division corresponding to the half pitch of the screw, as *j l*,

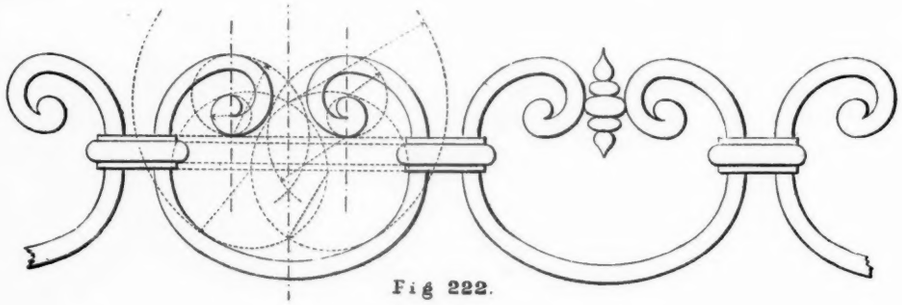


Fig 222.

m n o p q, and through these draw lines at right angles to the centre line *j k*. From any point where these lines intersect, as the point *l*, set off distances as *l a*, *l s*, equal to the external diameter of the screw, and *q v*, *q w*, equal to the internal diameter or the depth of the screw; and through these draw lines parallel to *j k*; as *a u*, *c v*, *t w*, and *s x*. Then set the centre line, *e f*, of the template *e f i*, to correspond with the centre line, *j l*, of the screw to be drawn; and make the point *e* of the template correspond with the point *b* of the centre line, line *j k*; and round the side *e i* of the template draw the line *b c* of the screw: reverse the position of the template so that the point *i* be to the left hand side, and draw along the side *i f* the line *b a*. To dispense with the reversal of the template, the parabola may be made double, as at *e z' a'*, so that the line *a b c* may be drawn at once, by running the pencil along the sides *z e i* of the template. The operation is made still more simple by forming the template out of a piece of card-board, as shown at fig. 226; the application of this being shown by the dotted lines 1, 2, 3, 4, 5, 6, 7 in fig. 225. The perspective line, as *v a*, showing the under side of the screw line, is put in by a parabola 7 *v a*, the height, *q v*, of which is less than that of *q u* by the depth, *u v*, of the thread of the screw. The perspective line, as *b' c'*, joining the central core of the screw with the thread,

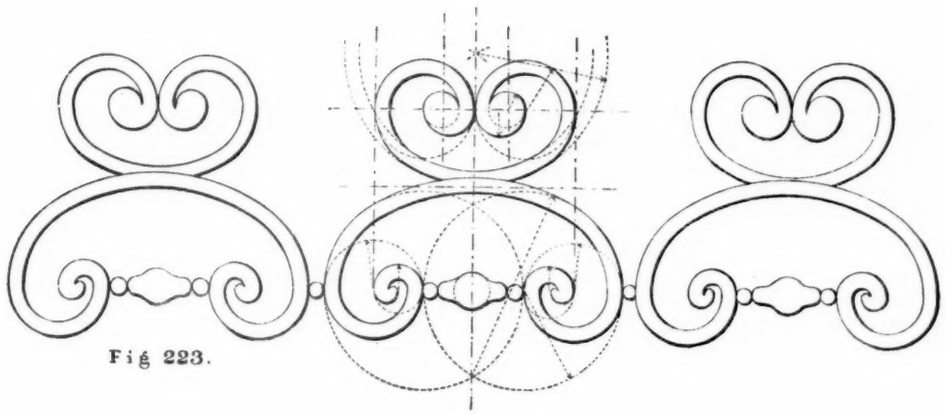


Fig 223.

Fig. 225.

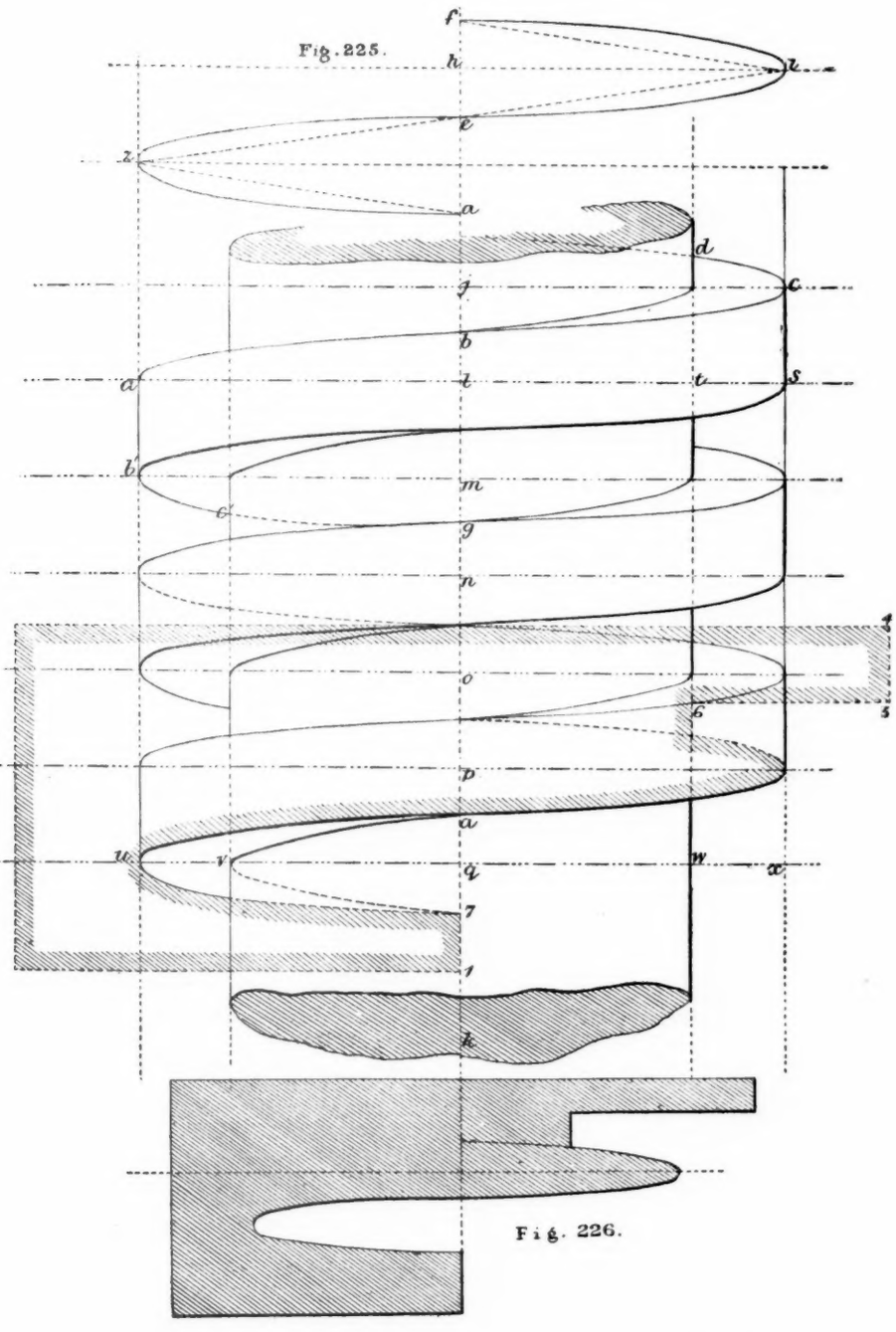
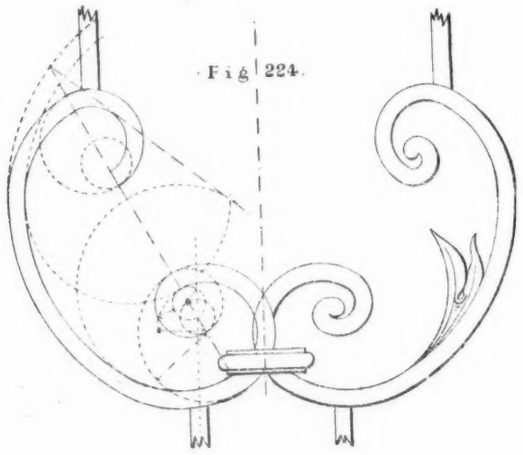


Fig. 226.

is obviously a continuation of the parabola. A quick method of describing a parabola, and sufficiently accurate on a small scale, is to draw a triangle *f e i*, and put in the curve by the hand and eye. We purpose, however, in a future note, to give instructions as to the describing of all the curves useful in the technical arts.

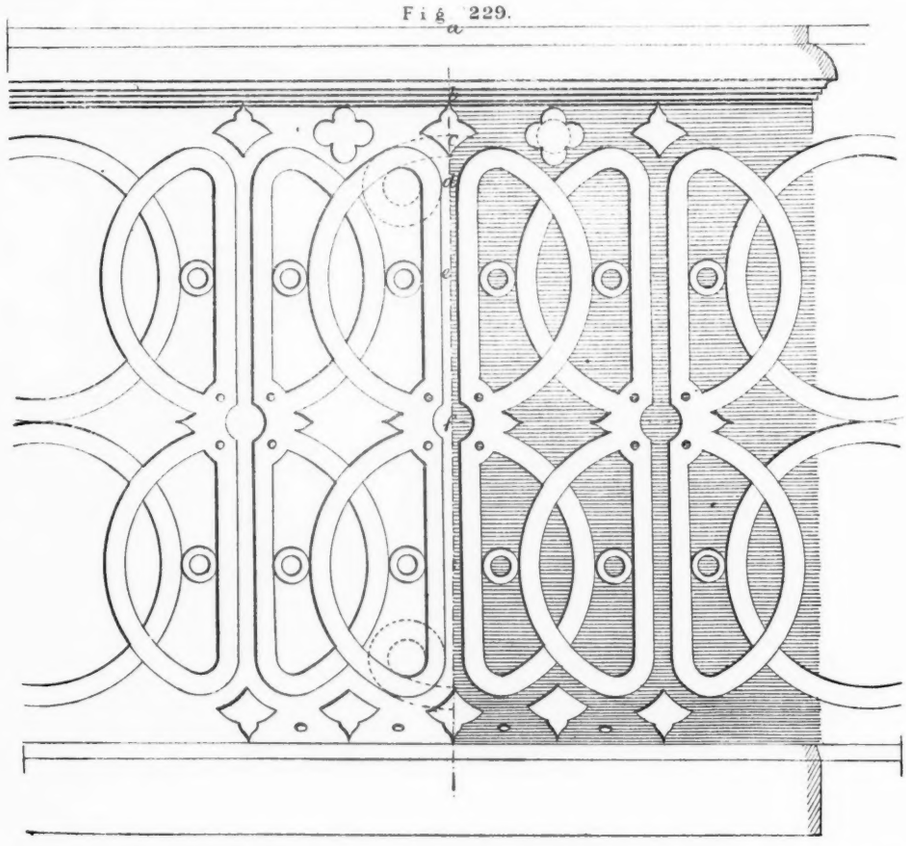
(53.) **Designs for Ornamental Cut-Wood Work, with Working Lines and Centres.**—In fig. 227 we give a design for a railing or open balustrade. Divide the height *a b* into 13 equal parts. Draw a line *a' b'* at right angles to *a b* as the base line; divide the space between the second and third

Fig 224.



of the divisions on the centre line *a b* into two equal parts, in the point *c*; and through this, and the fourth, eighth, eleventh and twelfth divisions on *a b*, draw parallel to the base line *a' b'*, lines, as *d c e*, *g 4 f*, *h 8 i*, *j 11 k*, and *l 12 m*. With the distance *b c*, set off from *b* on the line *a' b'*, to the points *n* and *o*, and from *n* and *o* draw lines at right angles to *a' b'*. Divide *b 1* into

Fig 229.



four equal parts as shown; divide the last of these into two equal parts, and through the point draw a line *p p* parallel to *a' b'*. From 1 with *b 1* set off to *q q*, and from these points describe the arcs of the circles at the base *q q*, as shown. From *n* and *o*, draw parallel to *a b* lines, as *n n'* and *o o'*. Then from the points *g* and *f* as centres with distances *g s*, *f 2*, describe arcs intersecting at the points *t* and *t*. Furnish the interior of these curves with the parts as shown. The arcs *u u* are de-

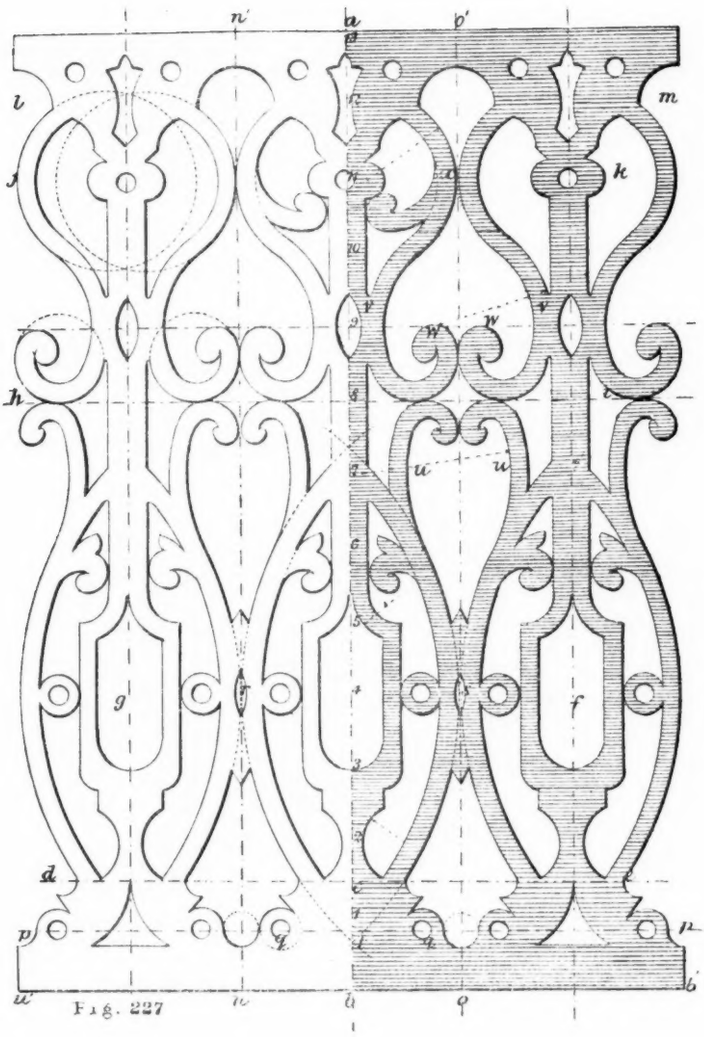


Fig. 227

Fig 228.

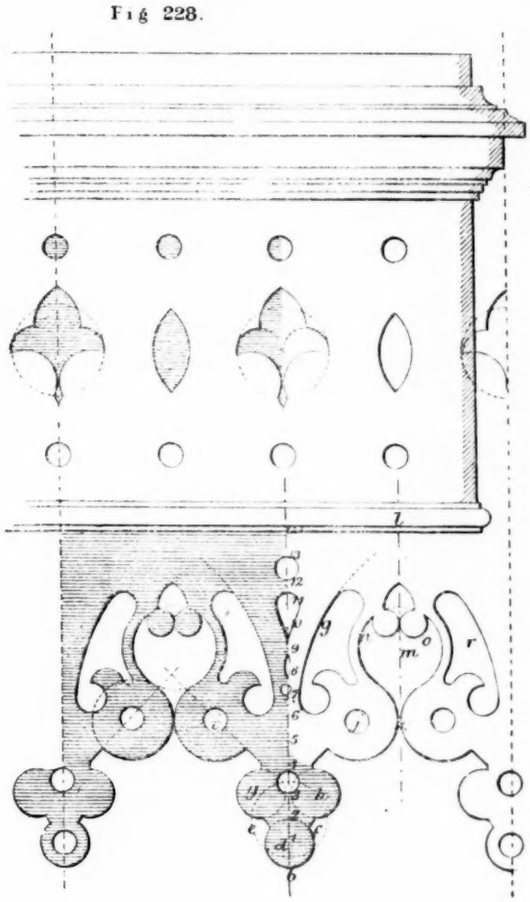


Fig 230.

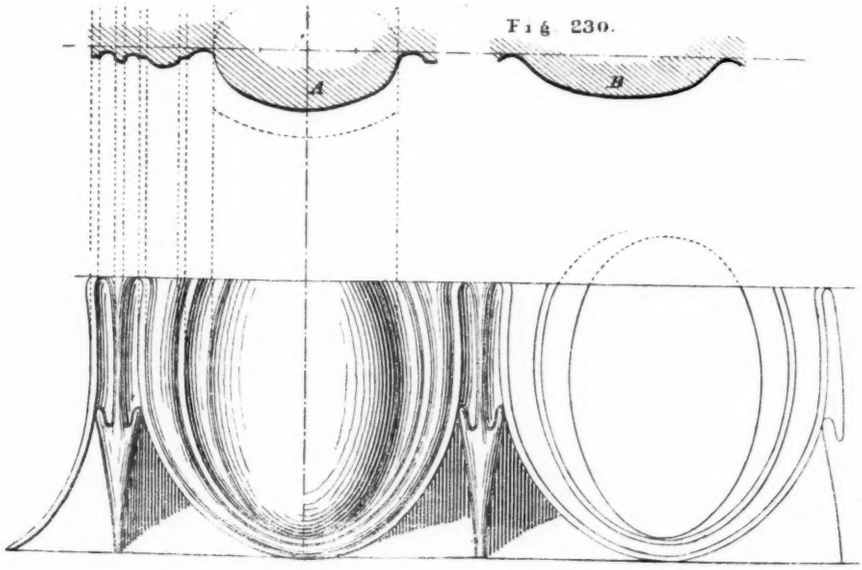
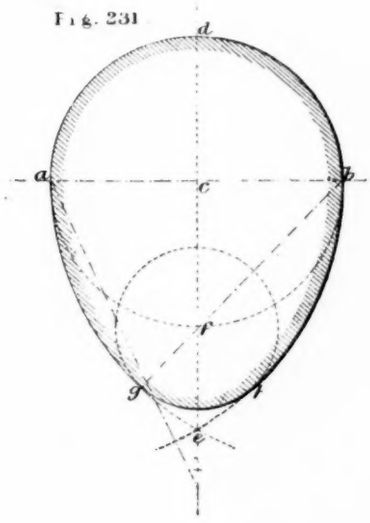


Fig. 231



scribed from the points 7 7′ as centres; the arcs *v v* from the points *w w;* the arcs *x x* from the points *y y*. These give the leading curves, and the remainder of the design can be put in as shown.

In fig. 228 we give a design for an eaves board. Let *a b* be the height of the lower part of the design, which divide into thirteen equal parts. Through the second, sixth, seventh and eleventh of these draw lines at right angles to *a b*. From point 1, with half the distance of the space between points 1 and 2 as radius, describe the circle *d*. From the point 2, with radius as shown in the drawing, describe the semicircle *e f*, and from point 2 draw lines at an angle of 45° to the line *c f*, cutting the semicircle; these points, as *g* and *h*, give the centres of the semicircles. From one centre of the circle, described between the points 3 and 4, draw lines at right angles to the line *e f*, to *i* and *j*. These are the centres of the parts of circles thus shown. Touching the circle at the point *k*, draw the line *k l* parallel to *a b;* on this line the centre *m* of the arcs *n* and *o* is found; 6 and *p* are the centres of the arcs *q* and *r*. The remaining parts of the design will be easily put in from the lines and centres shown.

In fig. 229 we give a design for a balustrade or balcony rail. Divide *a b*, the depth of the upper range of mouldings, into four parts. With two of these parts set off in the centre line to *c;* with five to point *d*, with 5 from *d* to *e*, and with eight from *e* to *f*. Through the points *c d e* and *f* draw lines at right angles to *a b*, and on these lines will be found the centres of the various circles and arcs as shown, and by aid of which the student will be able to put in the whole design.

(54). **Memoranda on Wrought-Iron and Steel.**—*Pulling or Tensile Strength of Iron Rods.*—This and the following table give the results of experiments made by Dr. Kirkaldy, Esq., in the "Titanic" Iron manufactured by the Waterloo Forge Company, Leeds; a quality of iron which the "Engineer" says is remarkable for its elasticity, "some bars being drawn out as much as a quarter of their length before breaking;" it is, perhaps, "the best iron known for fine screw-cutting and the best engineering work."

Pulling Stress.

Length 10 in.

Test No.	Stress. Elastic per square inch.	Stress. Ultimate per square inch.	Ratio of elastic to ultimate.	Contraction of area at fracture.	Extension. 50,000 per square inch.	Extension. Ultimate.	Effects.
D	lb.	lb.	Per cent.	Per cent.	Per cent.	Per cent.	
624	33,500	57,767	58·0	28·3	5·52	17·8	Fractured gradually.
604	32,500	53,853	60·3	41·2	10·0	23·8	ditto.
614	32,500	53,513	60·7	41·2	11·2	24·0	ditto.
584	31,500	52,507	60·0	41·2	12·1	24·4	ditto.
594	27,800	50,108	55·5	37·8	22·0	25·2	ditto.
Mean	31,560	53,549	58·9	37·9	12·1	23·0	

Turned to 1·382 in. diameter = 1·500 square inch.

Twisting stress.

Length of lever, 12 in.: length for torsion, 6 in. diameter.

Test No.	Stress. Elastic on each end.	Stress. Ultimate on each end.	Ratio of elastic to ultimate.	Torsion. 200 on each side.	Torsion. Ultimate.	Effects.
D	lb.	lb.	Per cent.	1 turn = 1·000	1 turn = 1·000	
626	840	2492	33·7	0·73	2·26	One end fractured.
					2·32	Other end ditto.
606	970	2281	42·5	1·17	2·43	One end fractured.
					3·00	Other end uncracked
616	930	2396	38·8	1·18	3·38	One end fractured.
					3·42	Other end ditto.
586	860	2307	37·3	1·25	3·44	One end fractured.
					3·45	Other end ditto.
596	770	2199	35·0	1·46	2·76	One end fractured.
					2·82	Other end ditto.
	874	2335	37·4	1·16	2·92	

Turned to 1·382 in. diameter = 1·500 square inch.

Steel is ordinarily produced by placing bars of wrought-iron in closed crucibles or retorts, along with a carbonaceous material, and subjecting the whole to a red-heat in a furnace for some time. Each bar is covered with the carbonaceous cement, and the bars when closely packed in the vessel are covered with sand, and the mouth closed with fire-clay. The cement is made of powdered charcoal mixed with fine ashes and a little salt. The heat is maintained for several days, according to circumstances; and when the process of conversion is completed the retorts are taken out of the furnace and allowed to cool gradually. The bars are in this condition called "blistered steel." "Cast steel" is produced by breaking blistered steel into small pieces, and placing them in crucibles, and subjecting them to a high temperature; and when melted the metal is poured into moulds and allowed to cool. When bars of blistered steel are heated and drawn out between rolls, or hammered, it forms "spring" steel; and when made homogeneous or uniform in texture, by repeated rolling and melting, it forms "shear steel." "Bessemer steel" is prepared directly from melted pig-iron placed in a peculiarly-shaped vessel, through which a stream of atmospheric air is forced. The conversion of melted iron into steel is the work of about twenty minutes, and the process is completed in one heat. The process of "puddling" already described has for its object the exposing of the iron during this process, which is necessarily a tedious and expensive one, being done by manual labour only—machine puddling has been attempted, and carried out with varied but not with the marked success necessary to enable it to supersede hand puddling—while, as will be seen, the oxygen in the Bessemer process is forced directly through the molten mass of iron, which is thus converted into steel, and in much heavier quantities in the same time than can be done by the old process. "Heaton's steel" is produced by a system of direct conversion, the molten pig-iron from an ordinary cupola being poured into a "converter" made of wrought-iron, lined with fire-brick, and in the bottom of which is a mixture of crude nitrate of soda, in the proportion of two hundredweights to two tons of the metal, with a small portion—twenty-five pounds—of siliceous sand; this mixture is covered with a perforated wrought-iron plate, through which the melted pig-iron passes to come in contact with the above mixture, when a re-action sets in, which is at once "basic and oxidizing." The conversion usually occupies about five minutes. The converted metal is then turned out of the converter, water thrown upon it to break it up into convenient lumps, which, being heated, are placed under shingling hammers, and made into lumps of what the inventor calls "crude steel." These, according as they are finally treated, produce either wrought-iron or cast steel. For wrought or "steel-iron," as it is called, the cakes of crude steel are piled and heated in a common balling furnace, and then rolled at once into "steel-iron." For cast steel the cakes of "crude steel" are "broken or cut up, melted in 60 or 80-pound crucibles, with about two or three pounds of spiegeleisen (a description of cast-iron containing an excess of carbon) to the 100 pounds of crude steel, or its equivalent of oxide of manganese, and some charcoal poured out into ingots of iron, *i. e.* into the usual ingots of moulded iron. These ingots of cast-steel are then tilted into bars, and are cast-steel fit for the market." Sir William Fairbairn proved the wrought-iron produced by this process to be "as good and stronger than Low Moor or Bowling," and the cast-steel "as good as any other process can produce." We shall have much fuller remarks on the above and more recently-discovered processes of steel-making in another and more elaborate article on the whole subject.

(55.) **Elementary Lessons in Cabinet-Making Design.**—It has been represented to us that a practically useful addition to our "Notes" would be a series of examples in connection with cabinet-making; many of these will obviously be useful in other branches of design. Some of the examples already given under the head of mouldings, scrolls, &c., will naturally come under this note, and we shall henceforth continue under it such examples of these which still remain to be given. In fig. 230 we give an example of the moulding, or ornament for a moulding, known as the "egg and dart." The section is shown in fig. A in same figure, the projection of the egg-shaped part being that of an ellipse as shown, but the projection of this may be less pronounced, as shown at B. There are various ways of describing the outline of the egg, some of which we now illustrate. In fig. 231 let *a b* be the diameter of the upper part of the egg, bisect this in the point *c*, and at right angles to *a b*, through *c*, draw the line *d e;* from the points *a* and *b* as centres, with the distance *a b* as radius, describe arcs cutting in the point *e*. According as the lower part of the egg is discovered to be more or less pointed or sharp, assume any point as *f*, near to or farther from the point *c*. From *a* or *b* draw through the point *f* a line touching one of the arcs as in the point *g*, and from the point *f* as a centre, with *f g* as radius, describe the arc *g* and *h*. Another method is shown in fig. 232. Let *a b* be the length of the "egg." Divide this into three equal parts in the points *c* and *d*, and from these points as centres, with *c a* or *d b* as radii, describe circles cutting in the points *e* and *f*. From *e* and *f* as centres, describe arcs as *g g*, joining the circles described from the points *c* and

Fig. 232.

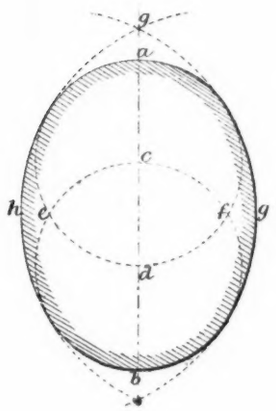


Fig. 233.

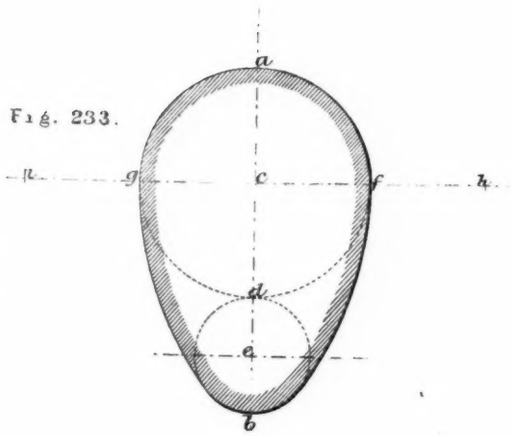
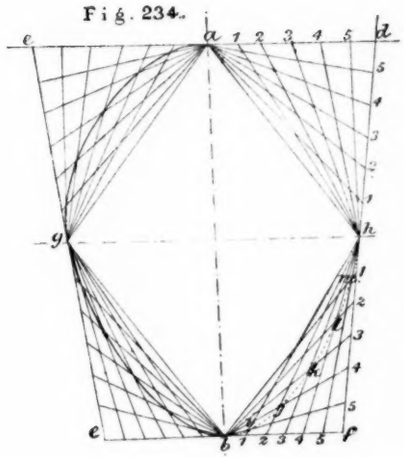


Fig. 234.



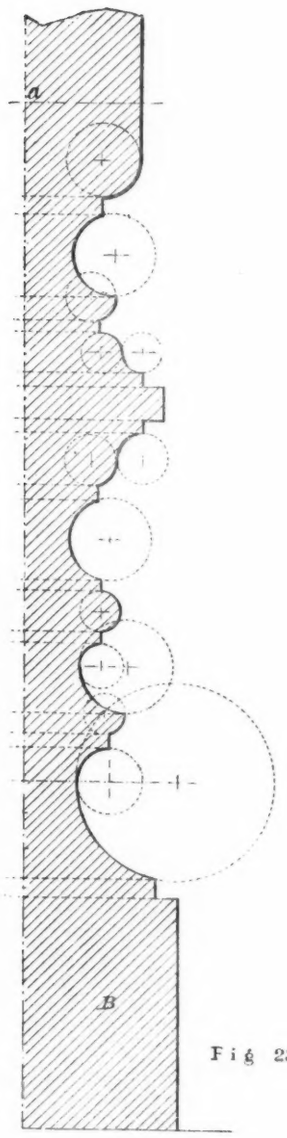
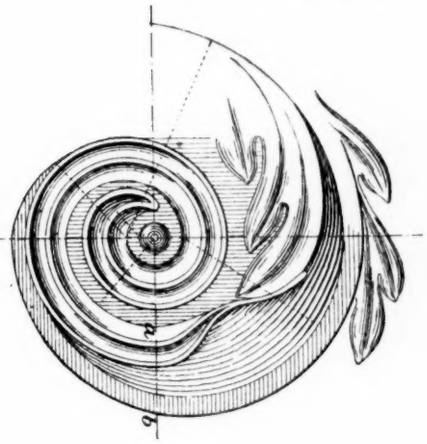


Fig. 235.

Fig. 236.



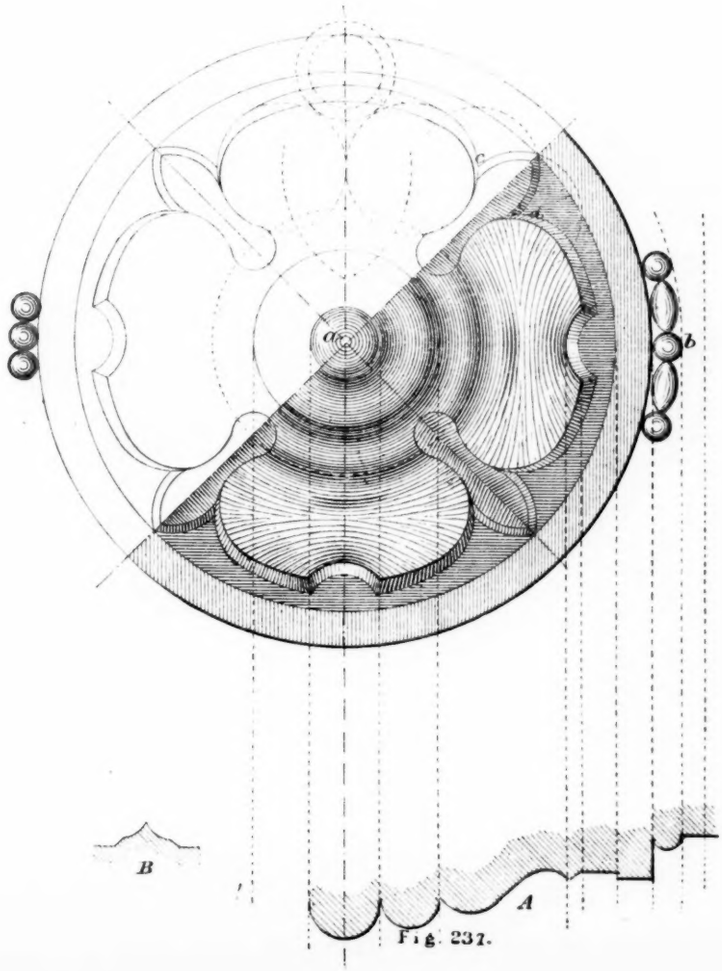


Fig. 237.

d. Another method is shown in fig. 233, in which let *a b* be the length of the egg; divide this into three equal parts in the points *c* and *d*; from *c*, with *c a*, describe the circle *f a g d*. Bisect the distance *d b* in the point *e*, and from *e* as centre with *e d* describe the circle *d e b*. Through the centre *c* of the large circle, draw at right angles to *a b* the line *h i*. With the distance *a b*, from the points *f* and *g*, set off to the points *h* and *i*. From *h* and *i* as centres, with *i g*, *h f* as radii, describe arcs joining the small circle *b* with the points *f* and *g*. Another method is shown in fig. 234, in which *a b* is the length of the egg. Through these points, at right angles to *a b*, draw lines *c d*, *e f*, and make these of unequal lengths and in any proportion desired, and join *c e*, *d f*. Divide *c e d f* into two equal parts in the points *g* and *h*. Divide *b f*, *f h* each into the same number of equal parts, and number them in the relation to one another as shown. From the points in *d h* draw lines to the

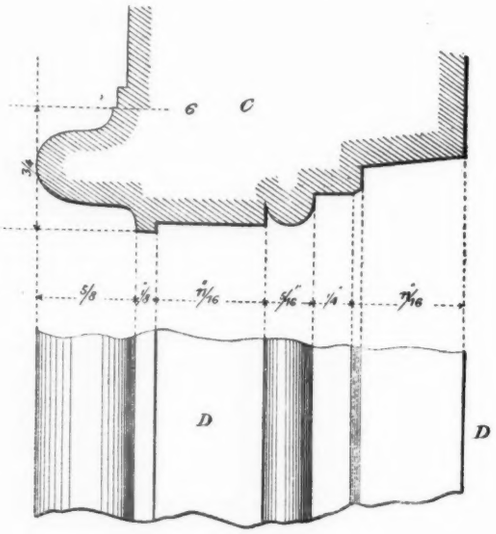


Fig. 238.

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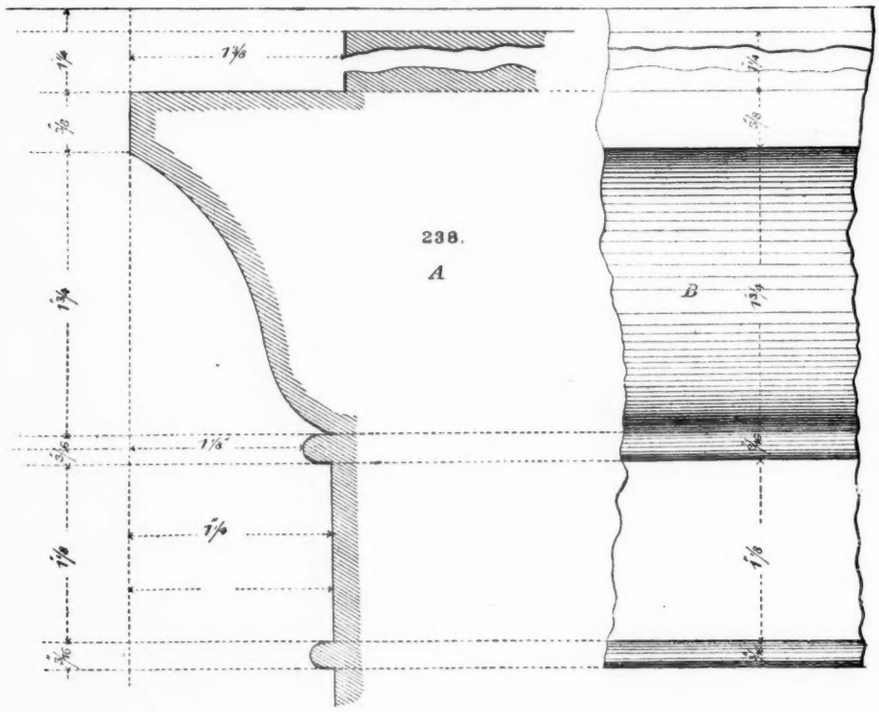

point *a*; and from the points in *f h* draw lines to the point *b*. The intersections of these corresponding lines—as the line 1 *h* with 1 *b*—will give points, as the points *i j k l* and *m*, through which, if a curve be drawn by hand or "curve set," one-fourth of the egg will be drawn; the remaining three-fourths, as those between the points *b g*, *g h*, and *c h*, being put in by a repetition of the process already described, and as shown by the dotted lines in the diagram. "Templates" being formed according to one or other of the methods now described, any number of the egg-shaped ornaments, as in fig. 230, may be put in along the length of moulding. In fig. 235 at A we give the first of a series of designs adapted for supports, as legs of tables, chairs, &c., and at B the mouldings of the lower part of a second example, one half full size, and at C the upper part of same. We have in a preceding note given examples of scrolls; in fig. 236 we give an example showing the termination of an

ornamental part having a scroll; at A, the section of part on the line *a b* is given. In fig. 237 we give a central ornament, showing the working lines and centres, and also a section at A on the line *a b*, and at B on the line *c d*. In fig. 238 we give

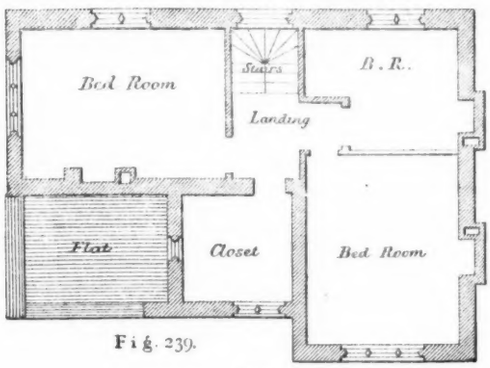

Fig. 239.

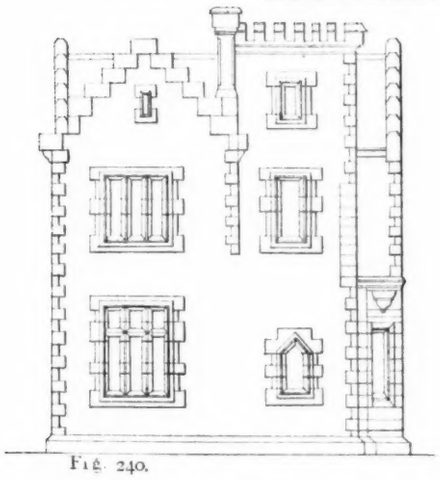

Fig. 240.

the mouldings for a cabinet or wardrobe; A being the profile of the mouldings of the cornice, B the elevation of the same; at C the plan of the running mouldings at corners, going from base to cornice; and at D the elevation of the same.

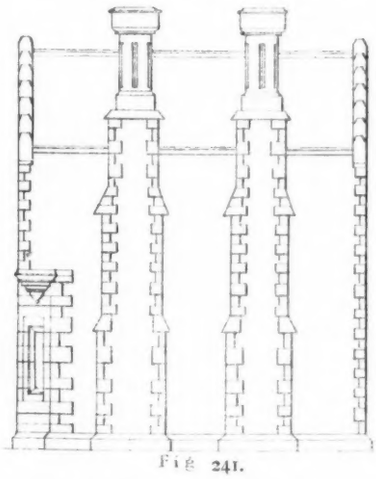

Fig. 241.

(56). **The Student's Sketch Book of Working Drawings.**—In fig. 187, from p. 48, vol. ii., we gave, under section C, "Architecture and Building," the ground plan of a villa cottage; in fig. 239 we give the bedroom or chamber plan; in figs. 240 and 241 the east and west end elevations.

ANTIQUE MARBLES.

WHAT is an "antique marble" and where is it to be obtained? By the term "antique marble" we do not mean an antique piece of sculpture executed in that material. We refer more particularly to the actual stone itself, in its unhewn and native condition. The real antique marbles are not to be confounded with those which have been quarried in more modern times, and which have received, or rather stolen that appellation, in consequence of a certain resemblance or similitude existing between them and their defrauded predecessors. It is to the continent we must look in the endeavour to trace out any reliable indications of a genuine antique marble. One of the difficulties encountered at the outset, is that the ancient names which once designated the quarries have been either lost in the lapse of centuries, or so altered that they bear not the slightest resemblance to the original names, which might perchance be retained and mentioned in some of the old works or manuscripts relating to mineralogy, geology, or architecture. Again, instead of the same marble being uniformly classed under the same designation, it was identified in a dozen different ways, according to the fancy of the writer. Sometimes it was described by the name of the locality or district in which the quarry was situated; at other times by its colour and other distinguishing characteristics, which, although peculiar in a general sense to the one kind of marble, yet varied sufficiently to cause much confusion, particularly when, as frequently occurred, the description was anything but lucid and intelligible. In order to lay claim to originality, an author, instead of retaining in his work the name of a marble exactly as designated in a previous treatise, will be found to alter it, in his opinion for the better. When it is taken into consideration that a discrepancy exists in this respect between the old classic authors, those belonging to the Renaissance epoch, and those again of the modern age, there is no necessity for making any remarks upon the difficulty of tracing out the quarries in which the marbles were originally to be found. After considerable research and labour, the *savans* and geologists of France have come to the conclusion that that country can boast of twelve quarries, which may really lay claim to the honour of having at some period or other produced a veritable antique marble. One of these marbles has received the name of the "Grand Antique," and its qualities are of a character which justly entitle it to that appellation.

According to geologists, there was a time when the material elements of the earth were in a state of liquefaction. It matters very little whether that condition of liquefaction was the result of the action of water or of heat, as the circumstances that are supposed to have ensued are exponible upon either the one or the other hypothesis. For the sake of convenience let us assume the latter. If we imagine that, while this state of fusion was in existence, a number of fragments of black marble with sharp edges and angles were surrounded by a white fluid similar to milk, which, upon cooling, formed around them a crystallized envelope, we have the formation of the marble in question. It not only presents this appearance to the eye, but when a section is made of it, the ground, so to speak, is of a pure white, strewn all over with black fragments having very acute angles. These are the distinguishing characteristics of the marble when it is of a superior quality. In some instances the black particles and spots are changed to a dark grey, which renders the material almost valueless for the purposes of art. A description of marble is quarried and sold on the continent which bears a close resemblance to this, the name of which it has usurped. But not only is it very inferior in quality, but a close examination will readily point out that it is not the genuine article. In the first place, the colours are not so vividly marked and contrasted, and the black nodules have not the same arrangement of sharp angles. The quarry in which the true "antique" is found was undoubtedly explored by the Romans, but their workings were not carried to any great depth. Rather more than twenty years ago the proprietor of this quarry made an attempt to work it.

At that time the French government were desirous of obtaining some fine blocks for the tomb of Napoleon, and the proprietors of the quarries contracted to supply them. After carrying on the excavations for more than a year the principal vein was reached, from which the blocks were procured which furnished the columns for the monument at the "Invalides" at Paris. It is to be presumed that this endeavour to restore to the arts the real "antique" was not found to be remunerative to the contractor, for the quarry was subsequently partially filled up and the future working of it abandoned. One of the circumstances which vouches for the truth of the statement that this quarry was

worked by the Romans is, that, in the attempt to re-open it, a medal of the time of Julius Cæsar, and various mining implements and quarrying tools of the same period, were discovered. Besides this corroborative testimony, there are numerous other authentic proofs, which fix the date of the first working of the quarry with historic accuracy.

A FEW NOTES ON MINES AND MINING IN HUNGARY.

IN giving here a brief sketch of the metallic mines of Hungary, we fulfil the promise made in a former number (No. 6, p. 499), and we are, as in the previous case, mainly indebted for our information to the official reports so courteously placed at our disposal by Baron Leithner, one of the heads of the Hungarian State Comptrolling Office. At the same time, the writer of these lines has gleaned occasionally from Professor Faller's interesting account of the mines in the district of Schemnitz.

The celebrated mining place Schemnitz, in Hungarian Selmecz-Bánya, stretches away in a valley surrounded by high mountains, which consist of a peculiar greenstone rock. The town proper is encircled by strong walls and battlements, which in former times were greatly needed for the protection of the valuable mining products against predatory attacks.

The gold and silver mines of Schemnitz occupy, with respect to age, extension, and production, the first place among the mining works of Hungary, and are on the whole worthy to be counted among the most celebrated mines of the Continent.

The origin of these mines falls, according to tradition, into the 8th century; but their existence in the 11th century is proved by historical documents. We meet, in and after the reign of King Stephen (afterwards St. Stephen) specially appointed governors ("Kammergrafen" in German) of Kremnitz, and in 1241 King Béla IV. issued the first decrees treating of mining privileges.

Through the constant dissensions in the country the working of the mines suffered considerably, and it is only since about the sixteenth century that something like a regular management prevailed.

The productivity varied at different epochs, but it brought, on the whole, advantages to the state directly through the profits realized, and indirectly through peopling mountainous districts otherwise little attractive.

The productivity at various epochs may be gleaned from the following instances:—

In 1569—

Silver	20,870 marks.[1]
Gold	203 „

From 1611 to 1671 the working of one of the galleries, the "Dreifältigkeits-Erbstollen," caused a loss of three million florins. The subsequent opening of two veins (Spitaler- and Bibergang) compensated within three years for the above loss, and gave in addition a profit of three million florins.

From 1690 to 1693 there were obtained—

Silver	2,851,515 florins.[2]
Gold	132,425 ducats.[3]

From 1683 to 1740 the whole of the works were in a critical condition, the water having overpowered the principal shafts.

Those portions of the mining district which were the property of the state had been actually abandoned in 1716, and eight years later all the works stopped.

About this time an Englishman, Isaac Potter, got up a joint-stock company for the resuming of the work. He introduced the first steam-engines (Papin's system) for the raising of the water, but his engines proved unsuccessful in coping with the enormous quantities of water that filled the pits and galleries.

The mining operations were again taken up by the state and by private companies, but only for a very short period.

The permanent abandonment of the interesting mines had already been spoken of, when the timely invention of effective pumps by Matthew Hell saved the Schemnitz works from being left to desolation.

With the introduction of better machines for the elimination of the water, the amount of precious metals brought to light increased rapidly. The quantities obtained from 1740 to 1759 are:—

Silver	1,219,700 marks.
Gold	38,757 „

From 1790 to 1858:—

Silver	1,793,733 marks.
Gold	38,757 „
Lead	592,411 cwt.

The money value of these three amounts to 63,876,816 florins.

The production between 1859 and 1863 was:—

Silver	110,078 pounds.
Gold	3,758 „
Lead	115,975 cwt.
Copper	16,685 „

representing a value of 10,281,743 florins.

In recent years there appears a decrease in the production of the precious metals,—the mines gave:—

	Gold.	Silver.
In 1867	378 pounds.	16,207 pounds.
1868	330 „	13,855 „
1869	256 „	13,442 „
1870	314 „	14,357 „
1871	205 „	12,446 „

The average annual production from 1790 to 1872 is 298 pounds of gold, 13,723 pounds of silver, and the average annual profit for the same period on these precious metals, as well as on the lead and copper simultaneously gained, amounts to 85,786 florins.

The chief motor of the various machines in work is water. The introduction of steam is but of very recent date (if we pass over that isolated and soon-abandoned attempt of Potter, in the middle of the eighteenth century), and as yet of very limited extent.

In olden days horse and hand-power were employed for setting the lifts, the crushing-mills, &c., in motion.

All the country round Schemnitz being very bare of natural waters, it is necessary to collect the atmospheric precipitations in large artificial tanks.

It follows from this mode of obtaining water that dry seasons exercise an unfavourable influence upon the productivity of the mines. Such injurious years were 1861, 1862, and 1863, when the tanks were not filled to the necessary extent. This long period of scarcity of water led to the introduction of the steam engine.

As usual, the introduction of something new met with no end of objections. Unfortunately one of them is too real as to be ascribed to mere prejudice. There are no coals near the mines, and thus wood has to be used as fuel. True, mineral fuel is not at a too unreasonable distance from the mines, but there are no easy means for the transport, the system of railways being as yet in its infancy in the fair countries which belong to the crown of St. Stephen.

There are sixteen tanks which supply the water demanded for all the mining machinery. The largest of them is sixty-seven feet[1] deep, and has a capacity of more than thirty-two million cubic feet. A large number of grooves or ditches, called "catch-ditches" (Fanggraeben), branch from this tank up into the wooded heights for the sake of collecting the atmospheric waters; the aggregate length of these grooves is two miles.[2]

The capacity of all the sixteen tanks amounts to over 230 million cubic feet, and the grooves which feed this space have an extent of nearly 10 miles.

Subterranean passages and tubes conduct the water from the tanks to the wheels of the crushing mills, etc. The total length of these tubes is about 8 miles.

The seven large engines applied for the raising of the water from the pits, shafts, etc., possess a nominal strength of 170 horse-power and are capable of lifting about 80 cubic feet of water per minute up to a height of from 500 to 600 feet.

We may as well give here the depths of the pits and galleries of the Schemnitz mines:—

Name of the pit.	Depth in feet.
Koenigsegg pit	462
Siglisberg „	1,182
Christina „	426
Amelia „	1,704
Willow „	648
Leopold „	1,140

[1] A mark = about eight ounces troy.
[2] A florin = two shillings.
[3] A ducat = nine shillings.

[1] A Hungarian (or Austrian) foot is practically equal to an English foot.
[2] A Hungarian mile = about four and a-half English miles.

Name of the pit.		Depth in feet.
Carl	pit	1,026
Ferdinand	„	780
Max	„	1,050
Andreas	„	1,368
Elisabeth	„	1,218
Michael	„	1,032
Nicholas	„	462
Wolf	„	918
Sigmund	„	1,152
Stephen	„	690
Assumption	„	834
Francis	„	240
Zips	„ Forming channels	894
Lill	„ for admitting light	630
Leopold	„ to the large gallery	468
Hut	„ "Emperor Joseph	342
Rudolf	„ II."	294
Three Magi	„	522
Trinity	„	162
John	„	444

The total length of all the open and worked galleries and passages amounts to 44 miles.

The number of miners, engineers, officials, &c. is about 5,000. The greater part of the mines is the property of the state, a few pits only belong to companies.

The miners work mostly on the "job" principle, that is, they are paid for the amount, taken together with the quality of work done.

The miners proper, the men employed in blasting and breaking in the pits and galleries, and those who are stationed at the lifts and other transport machines, are paid for the number of tubs pulled up or waggons dragged out.

The oil for lamps, the powder for blasting, the fusees, and the tools are given them by the proprietor. The tools are likewise repaired without expense to the workman himself.

All these materials are served out daily, and the wages are paid fortnightly.

The men employed in the separating sheds are paid according to the quality of the work performed.

The workman receives for every cwt. of separated ore (galena) from 42 to 70 kreuzer,[1] according to whether the quantity of metal contained in the sample amounts to from 30 pounds to 50 pounds and more.

The payment for sorting and sieving copper pyrites is effected on the same principle, but is, of course, considerably higher than in the former case.

These rates are increased by private proprietors in times when the price of provisions is high; the men of the government mines get no higher wages, but they obtain cereals and flour from government stores at moderate prices.

(*To be continued.*)

MANUFACTURE of Whiting and Paris White.—At the Plymouth works of Raynolds and Co., Bergen, N. J., four huge grinding mills are constantly running, breaking up the chalk and mixing it with water, which is constantly flowing in as the chalk mixture flows on. On leaving the mills the mixture passes along a series of wooden troughs, where the sand, which has a greater specific gravity than the chalk, is deposited, the chalk passing on into the settling pits, of which there are twenty-four. On being taken from the pits the whiting is partially dried on a flooring under which hot flues run. It is then cut up into large rough lumps and placed in racks on cars which run round on tramways into an immense oven. The heat from the flues in this oven is greatly increased by an air blast which also carries off the moist exhalations from the drying whiting. Twelve hours on the heated floor and twelve hours in the oven thoroughly dries the whiting, and it is ready for packing or the putty factory. The old process of drying, first for twenty-four hours on chalk stones, and then for thirty-six hours on open racks, was not only more tedious, but, from the variations of the temperature, was bad for the whiting for some purposes. These Plymouth works turn out about twelve tons of whiting a day—between 3,000 and 4,000 tons a year.

Paris white, of a fine quality, is used for finishing parlour walls, adulterating paints, making paper heavier and whiter, &c. For this purpose, what is called cliff stone, a better and harder quality of chalk, is used. Paris white is made much on the same principle as whiting, only being more carefully washed and more slowly dried. Many thousands of tons of cliff stone and chalk, imported from England, are worked up every year.

[1] A kreuzer = one farthing.

MATURE of Septicæmia (Blood Poisoning).—PAPILLON gives a digest of the principal results obtained from the admirable researches of Davaine on this subject, together with those also obtained by Vulpian and others. By subcutaneously injecting putrefying blood into guinea-pigs, rabbits, horses, and other animals, these animals are usually killed, and by employing their blood in the same way in various proportions, it has been established that the transmissibility of septicæmia in rabbits stops at about the trillionth of a drop of septic fluid, whilst so small a quantity as $\frac{1}{1,000,000,000}$ of a drop of septic fluid will produce death. Brine such as used for salting pork, &c. establishes septicæmia when subcutaneously injected, in spite of the presence of salt, the results being precisely the same as those obtained with decomposing blood. The virulence of the poison is greatly diminished by the presence of ammonia and sulphuretted hydrogen; consequently decomposition, when too far advanced, hinders septicæmia, just as the presence of alcohol in a saccharine liquid hinders the progress of fermentation; but if the gaseous products of decomposition of blood be removed by suitable absorbents (charcoal, oxide of lead, &c. &c.), the blood, kept in closed vessels at 37° (about blood-heat), becomes much more septicæmic than the same fluid simply exposed to the air for the same period. Davaine concludes from his experiments that septicæmia is putrefaction brought about in the blood of a living animal, the more highly virulent properties being produced simply by the putrefaction being brought about at a higher temperature than in the case of dead substances, and by the removal of the gaseous emanations, &c. as fast as they are formed. The animalculæ (bacteria, vibriones, bacteridia, spirilla) formed are consequent on the decomposition, but are not the cause of it. This conclusion is arrived at by Davaine because no life is noticeable by the microscope in highly diluted solutions of septicæmic fluids which yet possess great virulence. It does not follow, however, that the septicæmia is not wholly caused by germs of such small size as to be incapable of detection by the microscope.

Vulpian found some time ago that cyclamin when introduced into the œsophagus of a frog sets up an inflammation of the mucous membrane, an abundant secretion of mucous fluid being produced: this soon becomes charged with vibrios and the animal dies in a few days from septicæmia, its blood producing the same disease when injected into another frog. Extract of dulcamara produces analogous results.

Davaine shows that putrid or septic blood has properties by no means identical with that of gangrenous parts. As Pasteur showed in another way, gangrene is not identical with putrefaction, whilst septicæmia is.

Ferments other than those of putrefaction, when injected into animals produce their peculiar results; thus, Legros and Goujon found that choleraic symptoms are produced by the injection of diastase: synaptase, when injected simultaneously with amygdalin, was found by Claude Bernard to cause the production of bitter almond oil and hydrocyanic acid from the latter, thus killing the animal; similarly yeast and saccharine liquids injected into the blood cause the development of alcohol, causing mortal perturbation of the natural functions. Davaine finds that no difference is perceptible between the septicæmia of typhoid fever and that produced by the inoculation of putrescent animal matter. Cox and Feltz, however, did not deduce this result from their experiments, nor is Vulpian able to corroborate the statement. The latter was unable to kill rabbits by the injection of typhoid fever blood in small doses. He distinguishes between *bacteræmia or mycetæmia* where septicæmia, accompanied *necessarily* with the production of bacteria, is set up by inoculation, &c. with putrescent blood, and typhoid fever where the production of bacteria is only accessory. *Moniteur Quesneville, iii.* 484.

COATING Fabrics with Tin.—According to Richard Jacobsen, linen and cotton goods may be covered with a thick and flexible film of tin, which gives to them a very silvery appearance. The method to be adopted is as follows: Ordinary commercial zinc dust is rubbed up with a solution of egg albumin to a thin paste and applied to the goods with a brush or roller. When dry this coating is fixed by coagulating the albumin with steam, and the fabric is then placed in a solution of bichloride of tin. The tin is precipitated upon the zinc in a very finely divided state. The stuff is then washed with water and, after drying, put through the finishing machine, when the tin comes out with a brilliant lustre. A very beautiful effect may be produced by printing different designs in this way, or applying the material with stencil plates, and its use may be extended to decorations. It is even possible that this strong, elegant, and waterproof material may yet replace tin foil for packing certain articles.

The American Engineer and Inventor:

SELECT ABSTRACTS OF PATENTS RECENTLY GRANTED IN THE UNITED STATES.

[*For information concerning this department see the notice on the wrapper below the Contents of the Number.*]

1. Improved Axle and Axle Box for Vehicles.

This invention consists in the improvement of axle boxes. Grooves or recesses are made in the bearing surface of the box, which operate as reservoirs for the lubricating material. The box is fitted to a collar, and a nut is so fitted to the axle that when turned up it makes a joint with the end of the box, and confines the oil or other lubricating material. The ends of the box will become worn after a while, so that more or less of the material will escape, but the axle will still be lubricated from the material retained in the grooves and retarded by a shoulder or offset.

2. Improved Children's Photograph Chair.

This invention consists of a vertically adjustable head rest at the back of a child's chair, in combination with an adjustable back and band for waist, for supporting small children steadily, so that they can be photographed clearly and accurately.

3. Improved Beer Cask.

This invention has for its object to prevent the heads of large beer casks or tuns from being started or sprung by the pressure of the beer in working, and thus prevent the consequent leakage and loss. The invention consists in the combination of the rod having a head upon one end, a nut upon the other end and screw threads of the same pitch and running in the same direction upon both ends with the cross bars and the heads of the casks. By this construction, the threads of the said rod sinking into the wood of the said heads and bars prevent any beer from leaking out around the rod.

4. Improved Journal Box.

This invention relates to the construction of journal boxes for shafting and similar purposes, and consists in the mode of tightening the box to the journal when, from wear or other cause, it has become loose. It consists of the base, cap, and two adjustable side sections. The base may be the plate of the pillow block, or it may be a separate plate. The cap fits on to the top of the pillow block and journal in the ordinary manner. The adjustable side sections are made with the back of each section recessed or cut away, with flanges which fit on the ends of the pillow block, and with the projecting lips which enclose and hold the adjusting screw. The back side of the section is cut on an incline. The adjusting screw is attached to a movable block with inclined face, and is provided with a collar. The block is allowed play up and down; and the inclined surfaces of the section and block being reversed and placed in contact with each other, and the screw stationary longitudinally, it will be seen that, as the screw is turned, the block will be moved up or down, according to the direction in which the screw is turned, and will act as a wedge.

5. Improved Stop Cock.

This invention consists in the improvement of stop valves. It is proposed to pivot the two valves by ears to a cross head, which screws up and down the valve stem, and to arrange the pivot pins in inclined slotted round holes, which are so inclined that when the discs cease their downward movement the further downward movement of the cross head will force the discs against their seats, and at the beginning of the up movement draw them away from the seats. Cams or dogs are also pivoted to the cross head on the same pins that are used for pivoting the discs, and have an eccentric face acting on the back of the discs, and a projection extending to within a short distance of the valve stem, so as to be acted on by a collar on its lower end. By this arrangement, when the cross head is screwed down on the stem till the stems of the cams are brought against the collar, it will, by its action on said stems, force the cam faces powerfully against the discs, and thus greatly aid the pivot pins and the slots in pressing the discs against their seats, both to close them tightly and to strongly resist any impulses of the water against them. The cams are arranged in slots in the cross head, by which they are placed in the plane of the axis of the discs and the valve stem. The right-hand threaded part of the stem screws through a nut in the cap below the stuffing box when the stem has endwise motion, to raise the lower end of the stem above the water way when the valves are open, and return it to the working position when the valves are closed, while the raising and lowering of the discs with the cross head are effected by the steam, by reason of a reversely threaded part which moves the cross head down by the same movement that screws the stem down, and up by the same movement that raises the stem.

6. Improved Loom for Weaving Piled Fabrics.

For withdrawing the wires used in weaving pile fabrics, a hook is provided with a guard on one side of it to wear against the side of the wire head to which the wire is attached, to prevent the hook from shifting so far over as to engage the next wire at the same time, and to insure the hook against shifting in the other direction, so as to slip off from the head of the wire. The face of the hook, and also the face of the shoulder of the plate or head of the wire with which the hook engages, is made like a half dovetail, bevelled, and relatively arranged with the guard so that they are locked together, and all liability to disconnect during the operation of withdrawing the wire is avoided.

7. Improved Hatchway.

This invention consists in an arrangement of gearing, in connection with sliding hatchway covers, whereby the elevator carriage is caused to automatically open the way for passing through and to close it after passing, so that all danger of accidents by falling through open hatchways will be avoided, and the keeping of them closed to prevent draught in case of fire will be insured. The essential feature of the invention is one or more toothed wheels on opposite sides of the elevator way next to the guides in which the elevator runs, gearing with the sliding door by a rack or racks, and a rack or racks on the top of the elevator carriage, which connect with said wheel or wheels sufficiently in advance of the carriage to throw the door or doors open by the time the carriage rises to the passage, and corresponding rack or racks on the lower end of the carriage connecting with the wheel or wheels, as soon as the carriage arrives above the passage, in such manner as to reverse the action and shut the way.

8. Improved Shoe Last.

This invention relates to the spring lock bolt that fastens together two sections of a last, and consists in the application thereto of two plates and a hook, whereby it becomes unnecessary to cut so near to the upper surface of the last, to make the bolt so long, or to use the ordinary transverse pin by which the last hook is enabled to unlock the sections.

9. Improved Knife Cleaner.

The object of this invention is to furnish a practical instrument for families, boarding-houses, and hotels, by the use of which knives and forks may be quickly cleaned without dust. An outer case is connected by screws and suitable brackets to the wall. An inner box is made movable therein and may be taken out to be used on a table. A drawer and button contains the polishing powder. Above the drawer is a horizontal board divided into two parts by a projecting piece, to which are applied lids fitting exactly into the parts of the board. The inner sides of the lids as well as of the board are lined with strong buff leather pieces glued and riveted to them, so as to adhere rigidly thereto. The polishing powder, with moistening material, is placed on one side and dry polishing powder on the other. The knives are placed between the leather surfaces, and first rubbed in the moistened powder slightly, then in the dry powder, till perfectly clean and polished. The box is slightly drawn open, so that the escaping powder may drop therein. The lids are not closed when forks are polished, the rubbing of their prongs being sufficient.

10. Improved Beer Cooler.

This invention has for its object to furnish an improved apparatus for cooling beer, mineral water, &c., which shall be so constructed as to thoroughly cool the beer without injuring its flavour. In the box beneath the ice chamber is placed a cask to receive the beer from a cask placed in the cellar or other convenient place. The beer is introduced into the cask through a pipe inserted in one of its ends. Three or more wooden tubes pass through the cask from end to end, and are placed at different heights in said cask. The ends of the tubes that project from the heads of the cask are connected alternately by flexible tubes, so as to form a continuous pipe. The lower end of a pipe is connected with the end of the lowest tube, and its upper end extends up nearly to the ice chamber. It is made funnel-shaped to receive the ice water from the discharge pipe of the said ice chamber. By this arrangement the ice water is introduced into the lowest tube and escapes from the highest, the discharging end of said highest tube being provided with a short elbow pipe, so that the said tube may be always full. An air chamber is placed in the box above the cask and below the ice chamber, and is connected with the said cask by a short pipe. The air chamber is designed to receive any excess of gas that may be in the cask, and which might prevent the said cask from being readily filled.

11. Improved Heating Stove.

This invention relates to stoves which have a down draught through the fuel, and consists in the arrangement of a plate to form that side of the hanging grate which is opposite the smoke pipe. Through a hollow standard a pipe passes upwardly into the combustion chamber. In the latter is hung the basket grate that is provided with a removable cover, through whose holes the air is drawn to produce the down draught. One side of the basket grate is a broad plate, which comes directly between the smoke pipe and the other part of the grate. By this construction, when there is sufficient heat to create a vacuum in the chimney, a current of air rushes through holes through the fuel in the grate, under the plate, and into the chimney. In order to moderate the strong draught which is thus produced, slides in the ash-pan are moved so as to admit air.

12. Improved Method of Adjusting Circular Saws.

It is proposed to have a loose collar or disc between the saw and the fast collar, with adjusting screws screwing through the fast collar against or into the loose collar, to adjust the saw true in case the fast collar is not exactly true, or in case the saw itself is not ground true.

13. Improved Automatic Gate.

This invention relates to that class of gates which are opened and closed automatically as the vehicles approach, and subsequently closed behind them after the passage of the vehicles therethrough. The invention consists in combining with a gate latch a vibratory lever, with arms connected at the lower end with a bar inclined on its subjacent face.

14. Improved Gas Retort.

This invention consists of a retort protected from direct contact of heat by the brickwork in which it is set, or partly by the same and partly by another retort, in combination with one or more retorts wholly exposed to the heat of the furnace, for gradually heating the substance of which the gas is to be made; the object being to provide an arrangement whereby resin or volatile oil can be successfully treated, in which they are subjected from the beginning to the intense heat of retorts directly exposed to the heat, and sufficiently hot to convert them into fixed gas, which they cannot be in the ordinary retorts.

15. Improved Paper File.

The object of this invention is to furnish to merchants and business men a cheap, durable, and convenient paper filer, by which letters, bills, checks, or other papers may be quickly and neatly filed and compactly held together. The invention consists of a device bent of suitable wire or other metal in such a manner that the top part holds, in connection with the spring action of the bottom and side parts, the papers placed on file between them.

16. Improved Paint Brush.

This invention relates to paint and other brushes, and consists in a novel mode of constructing and combining the handle, bristle compressor, and shell, so that the bristles may be adjusted when worn, utilized almost entirely, and then replaced with new bristles, all with but little trouble and by almost any one.

17. Improved Mangling or Wringing Machine.

This invention consists of an arrangement of long levers and springs to obtain the pressure on the pressure roller by light and sensitive springs, which are better adapted for obtaining a wide range of movement than the strong heavy springs which are necessary when short levers are used.

18. Improved Spring Bed.

The object of this invention is to construct a cheap and durable spring bed of simple construction. It consists of grooved lateral supports for double-acting spiral springs, which are connected by slats or cane pieces, and held in position by straps passing through the springs.

19. Improved Ear Protector.

The object of this invention is to provide suitable and convenient means for protecting the ears from frost and cold; and it consists in shields or coverings for the ears, connected together by an elastic cord, and with the central fronts or outsides formed partly of cloth and partly of gauze, so that the shield will not interfere with the transmission of sound.

20. Machines for Swaging and Finishing Horseshoe Nails.

The first invention consists of a die on the side of a vertical wall, and a horizontal reciprocating die working toward and from it below a screw feeder, and a bar parallel with it, by which the nails are fed along, points downward, to these dies, to be bevelled to the required shape flatwise at the points, the movable die being so timed as to come against the points as they pass in front of it. The feed screw and bar are adjustable vertically to regulate the length of the bevel for the points. The invention also consists of a weighted lever combined with said feed devices and bevelling dies to retain the nails between the dies while being acted upon. There are also a vertical stationary die and a movable punch, and a pair of holding dies, in combination with the said feeding devices, for trimming the edges or narrow sides of the nails for about half their length from the point, more or less, the nails being presented to the said trimming dies by dropping, point foremost, from the feed devices in front of the stationary trimming die, and being caught at the head by the holding dies, so that the point to be trimmed is suspended in front of the stationary trimming die and held till the movable trimming die comes up and forces it through the other one and out of the holding dies. One of the said holding dies has a slight movement to open and let the nails drop in freely, and then close on them to hold them snugly till the movable trimming die acts. The invention also consists of an arrangement of the stationary bevelling and trimming dies on a supporting block, which is pivoted to the frame at one end, and confined by a locking pin at the other end, in such manner that by removing the locking pin the block can be readily swung over on its pivot to afford ready access to said dies for repairing them; and an arrange-

ment of the crank shaft is provided which works the movable die stock by a crank or wrist pin, so that it can slide away from the stock readily, to allow of withdrawing the stock to grind the dies without taking them off, and a combination of a latch and collar with the shaft for holding it in connection with the stock. The same inventor has also patented a machine for finishing horseshoe nails, which operates as follows: The nail is placed between two threads of a screw. The screw being rotated, carries it forward until it reaches a die where the hammer strikes and points it. It then passes to and off the screw end, against which it is held by suitable devices until the pushers carry it through other dies, the head of the nail causing the holder to rise. This effectually trims the nail. If a nail is larger than those previously pointed and trimmed, the screw is drawn back, and *vice versa*, if smaller; while increased space between the nails, as they approach the die to give room for the handle, is obtained by the increasing width of thread.

21. Improved Medical Compound and Medicated Food.

This invention consists in extracting from vegetable substances those most nourishing ingredients which are combined with phosphorus, and in subsequently adding them to the substances to be eaten or imbibed as articles of food or medicines. Thus, for example, it is proposed to withdraw from vegetables, such as peas or beans, the ingredients above referred to, discarding the indigestible, or at least with difficulty digestible, residue of such vegetables, and to add the matter extracted to chocolate or other suitable article of food. A certain quantity of peas, for instance, is powdered and then treated with water. The mixture is filtered, and so much of the moisture is evaporated as to leave the remainder of a more or less viscid consistency. Gastric juice or finely cut pieces of a calf's stomach are next added. Finally, the mixture is dried at a moderate heat. The substances with which the phosphorus is thus mixed it is proposed to call "phosphorine."

22. Improved Animal Trap.

This invention has for its object to furnish an improved animal trap, which shall be so constructed that the entrance of the animal will reset the trap for the next animal. By suitable construction, when the trap is set, as the animal enters the box and steps upon a platform he tilts said platform, which draws back a catch lever and allows a wheel to be revolved by a spring until a pin, upon the other side of the wheel, strikes a stop spring. This movement closes the doors and leaves the animal shut up in the box. The animal then sees light entering through another box, and, trying to reach it, he raises a gate, steps upon and operates the trip platform, and passes into a third box whence he cannot escape. This movement withdraws the catch lever and allows the wheel to revolve until the next pin upon its other side strikes against the other stop spring, opening the doors and again setting the trap.

23. Improved Knapsack.

In this invention the frame is made of small, tough, flexible pieces of wood, butted together at the end and secured at the corners by strong duck, canvas, or other heavy cloth, in which the sticks are bound at the edges. Between the sticks are strong thick pieces of leather fastened to the cloth and turned around the corners. They are to hold the sticks apart the width of the cloth pieces, and to afford sufficient strength for holding the covering and the straps which are attached to them. About half-an-inch from the end the wood pieces are tied together by strong leather strings. The cloth pieces of each corner are connected together by straps which prevent them from sliding up on the rods, and bind the frame strongly together at the corners. The cover, of flexible material, is shaped so as to envelope all sides except one, and, having flaps, is fastened on by metal loops with a toggle piece, the said loop being inserted through the canvas and leather corner pieces; and the flaps are provided with means of buckling together when folded down. The lower loop straps also unite with the straps, the said straps passing through the metal loops and meeting and buckling together at the middle of the bottom of the knapsack. The loops are connected to the knapsack by the metal loops, that they can be readily shifted as may be required for changing the knapsack sides about. The shoulder straps are connected to the back plates by rivets which are suitably arranged to allow the straps to turn freely as required in separating and adjusting them on the wearer, also for shifting them about to different positions for ease in sustaining the load. The knapsack frame is covered with linen or cotton duck, having on one side a waterproof flap of vulcanized rubber cloth. It may be reversed on the back by simply hooking it from the back pad, turning it, and changing the supporting straps to the opposite side. By this means the canvas back may be turned outward in hot weather, and the waterproof flap outward in rainy weather. The knapsack may be worn at almost any place desired on the back.

24. Improved Scaffold.

The object of this invention is to construct a scaffold for the use of painters, carpenters, and others, which may be easily set up and taken to pieces and readily transported. The invention consists of two main supports resting on standards and composed of several pieces, connected by strong staples, the uppermost pieces suspending, by block and tackle arrangement, an adjustable platform, which may be elevated to the full height of the supports.

25. Improved Lawn Mower.

This invention has for its object to furnish an improved instrument for shearing the edges of grass plots along the edges of walks, beds, &c. where the grass cannot be cut by the lawn mower. To the lower end of the standard or frame, in an inclined position, is secured the lower or stationary blade of the shears. To the blade, near its rear end, is pivoted the rear end of the upper blade. To the latter, near its rear end, is pivoted the lower end of the connecting rod, the upper end of which is pivoted to the crank. Several holes are formed in the connecting rod to receive the crank to enable the instrument to be adjusted. The crank is attached to the end of a shaft, to which, within the frame, is attached a small grooved pulley, around which passes a band, which also passes around a larger pulley attached to a wheel, which revolves in the lower part of the frame. The wheel is designed to roll along the ground at the side of the edge to be sheared, and carry the machine forward, and at the same time by its revolution to work the movable blade. The standard and frame may be adjusted upon each other to adjust the lower blade to the proper height above the ground.

26. Improved Cooking Stove.

The object of this invention is to furnish a cooking stove, constructed in such a manner that the different parts may be easily packed and shipped, to be mounted by any tinsmith, and the parts exposed to the fire easily replaced. The oven is placed below the fire-box, and supplied with a steady uniform heat around both sides. The invention consists in the combination of sheet and cast-iron parts in such a manner that the front, back, and top plates are of cast-iron, the side and bottom plates of sheet-iron, the interior parts also being of sheet-iron and cast-iron, and connected by wedge strips of sheet or solid iron. The flues are arranged so that the draught carries the heat from the fire box around the oven and below the bottom of the same up the chimney.

27. Improved Circulating Valve for Fire-Engines.

The case is attached to the discharge chamber of a fire-engine by a screw, and a pipe is attached with the suction. When the pressure rises in the discharge by the shutting off of the escape, the water, acting on a small valve, lifts it against a spring and acts on the top, thus forcing down another valve and opening a passage through which the water escapes from the discharge to the suction, and thus relieves the pressure in the hose. The valve is held up, when not subject to water pressure, by a spring, and may be adjusted for different pressures or different pumps. This device is claimed to be more instantaneous in action than a relief valve.

28. Improved Boot and Shoe Sole.

This invention relates to wooden soled shoes, for skating or walking purposes, and consists in a peculiar method of applying double nails in fastening the uppers of shoes to the soles, so as to form, practically, a metallic thread, which makes the article of manufacture to all intents and purposes a sewn shoe.

29. Improved Boot Jack.

The object of this invention is to furnish a boot jack which takes hold firmly of the boot at toe and heel, and allows its easy pulling off. This invention consists of two jaws with inclined slotted parts, which grasp the heel by the action of the foot on a pivoted U-shaped rod frame guided therein.

30. Improved Broom.

This invention relates to the construction of brooms, and consists in a wooden handle with a tapered end, and a tubular socket for holding broom-corn, or other material for the brush. In practice the butts of the broom-corn are inserted and closely packed in the socket. The tapered end of the handle is then forced down among them, thus wedging them between itself and the inner sides of the socket. When the brush needs renewal the screws which are used to secure the socket and handle together are removed, the handle withdrawn, and the stumps of the corn extracted. The socket is then refilled as before.

31. Improved Reversible Harrow Teeth.

This invention consists in providing a harrow tooth with two arms or shanks, which, forming an angle with the tooth, are attached on different sides of the longitudinal bar of harrow frame, and thus brace it in two directions.

32. Improved Combined Scissors and Tape Line.

The object of this invention is to combine the common scissors or shears with a spring tape measure, so that, by the increased convenience in handling and readiness of having both within reach, a very useful and practical instrument is produced. The invention consists in placing the centre of the tape line case on the extended screw pivot of the scissors, so that both instruments can be used without interfering with each other

33. Improved Animal Trap.

The object of this invention is to furnish to farmers and others a mole trap, durable on account of the strong and substantial parts. The invention consists of two legs with a collar at each end, connected by a strong spring of plate metal. A piece of square metal is wedged between the smooth legs, so that the slightest touch will close the legs with strong force, capturing or killing the animal within reach.

34. Improved Combined Collar and Cravat.

This invention has for its object to produce a simple combination of bow, cravat or necktie and collar, being more particularly intended for use on paper or part paper collars, though applicable to other kinds. The invention consists in constructing the collar with projecting flaps at the ends of its outer fold, for forming the base of the cravat, and with a projecting T flap at one end of its inner fold for forming the outer part of the collar, the T flap having several button-holes to allow its parts to be fastened to the same stud by which the collar is held to the front of the shirt.

35. Improved Children's Carriage.

This invention has for its object to furnish a combined perch and spring for a child's carriage, which, should the wheel strike an obstruction, will spring longitudinally, so that the body of the carriage will not be stopped with a sudden shock. The invention consists in bending the ends of the perch upward and inward into the form of the letter C, and pivoting the same to the toe irons attached to the carriage body.

36. Improved Turn-Table.

This invention has for its object to furnish an improved turn-table for railroads. The centre or step plate rests upon a bed of brickwork, and carries a cast steel socket to receive the centre balancing screw. At the end of the track are secured the bearings of two wheels, in such positions that they may be directly beneath the end of the track of the turn-table when in position for the engine to pass to or from said table. The wheels are designed to take the weight off the circular track upon which the table revolves, when an engine is passing to or from said table. The stringers to which the rails are attached are bolted to each other. Each is made in two equal parts, which are strengthened at the joints and bolted at the centres to the centre cross beam. To the stringers at the inner sides of the end cross beams are bolted the truck frames. To the under side of the centre cross beam is bolted a cast-iron plate, which plate is made sufficiently long to receive the bolts that secure the splice bars to said central beam. Through the centre passes the pivoting screw, the bearing for which is lengthened by a boss formed upon the lower side of said plate. The said screw can be securely locked in place, and may be turned one or more revolutions, so that the table may be accurately adjusted. The table is locked, with the rails in line with the rails of the track, by the V-shaped locking bar attached to the shaft which works in bearings attached to a suitable support, which is worked by a lever. The free end of the V-shaped locking bar enters a groove in the catch-block, one of which blocks is attached to each end of the track of the turn-table. Suitable stays prevent vibration and hold the table securely and firmly under counter strains.

37. Improved Butt Hinge.

This invention relates to the construction of hinges for hanging doors and for other purposes; and it consists in a divided leaf and in a pintle pin fast in the other part of the hinge. The pintle is stationary, and each part of the divided leaf bears its own portion of strain whichever end of the butt may be up; and the butt may be reversed as may be found convenient, so that making the butts in pairs or rights and lefts is not necessary.

38. Improved Gyroscopic Toy.

This invention is an improved toy, which is so constructed that, by giving a rapid motion to a wheel suspended in it, it may be made to revolve in various positions and directions.

39. Improved Paint Compound.

This compound is claimed to possess antiseptic properties, which render it more desirable than other paints where such properties are not found. It is composed of plumbago, clay, silicate of potash or soda, and oil.

40. Improved Sofa Bedstead.

The object of this invention is to construct an improved sofa or arm-chair bed, which can be thrown open in such a manner that the seat or back of the sofa is not used at all for the bed, and consequently less worn, retaining its form and appearance. Any spring bottom can therefore be used for the bed part, and the whole be placed on castors, to be easily moved as sofa or bed. The invention consists of four parts, two for the back and two for the seat, hinged together, to be swung open by disconnecting the arm top pieces from the arm braces, which form the legs of the front part of the bed. The sofa back and seat form the outer side, a spring bottom the inner and bed part of the sofa bed.

41. Improved Medicine Spoon.

The object of this invention is to supply a spoon for the nursery, by the use of which the administering of medicine to children is greatly facilitated, without spilling the medicine. It may also be manufactured in larger sizes, and be placed on suitable supports on the bed table, so that the medicine may be filled into it before the actual time of taking has arrived. To the body of the spoon is attached, at the connecting point between bowl and handle, by means of hinges, a convex cover of the same size as the bowl, and resting edgewise upon it. A crescent-shaped opening at the foremost part of cover serves, when the same is thrown open, as a rest for the vial, to steady the hand for counting the drops of the medicine; when closed, for the purpose of allowing the contents of the bowl to flow freely into the mouth of the patient. To the lower side of the bowl are connected supports for sustaining the spoon in such a position that the medicine is level in the bowl and does not spill.

42. Improved Chair.

This invention has for its object to furnish an improved chair, so constructed as to yield as a person sits down in it and as he leans in either direction, thus avoiding the rigid resistance experienced in sitting in an ordinary chair, and which at the same

time adjusts itself to the weight of the person, and thus operates equally well with a light and with a heavy person. By suitable construction, when a person sits down in the chair, his weight compresses rubber blocks more or less, so that the said blocks will always adjust themselves to the weight they may have to support.

43. Improved Hinge.

The object of this invention is to furnish an adjustable hinge, by means of which the doors can be easily set to any position desired on the shrinking or swelling of the door frame and door, or adjusted up and down to prevent dragging or catching at the sill or top frame. The invention consists of a flange cast to one wing or leaf of a common butt hinge, to slide and be adjusted by set screws in a metallic socket mortised into the jamb and secured firmly therein by wood screws.

44. Improved Railway Frog.

This invention consists of a turn-out for mining railways, constructed with particular reference to the cars used in mines, in which it is necessary to have the wheels revolve on the axles, on account of the short curves necessary on such roads, and which said wheels, in consequence of so working, have considerable lateral play. The invention comprises improvements in the form or construction of points of switch rails. The peculiarities of these points are: The pointed end of one switch point terminates at such a point in the line of the outside rail of the branch track that the gauge is increased on a radial line about one and a-quarter inches; and the pointed end of the other point is so arranged that the gauge on another radial line is increased about an inch and a-half, so that notwithstanding the lateral play of wheels on the axles they will be switched off on the curve with certainty in case the car is pulled by the team to the left. In some cases, where the turn-out is not very short, so that the team will not naturally turn out enough to pull the car over into the switch, it is desirable to employ a movable tongue, which is pivoted at the concave end of one switch point by a pin extending down through the wing plate, and having an arm fixed on it, and extending outside of the rail a suitable distance, and connected with levers and weights for holding the tongue open or closed, as may be desired, the weight being put on one arm to hold it open, and the other to hold it closed. It is proposed to have a cord or rod extending along the track each way, so that when it is desired to have the car take the course which the tongue would, under the influence of the weight, prevent it from taking, the driver can shift the tongue while riding on the car by reaching out and pulling the cord.

45. Improved Meat Chopper.

This invention consists in a novel mode of combining a rotary table and a series of chopping knives; also, in a peculiar mode of constructing the knives, so that, when the edge of a knife loses its exact horizontal line by sharpening, it may be still adjusted on the stock so as to strike horizontally; and, finally, in a novel mode of preventing the mechanism from being broken by the contact of the knives with bones or other hard substance.

46. Improved Curtain Fixture.

This invention consists in suspending a curtain from the cornice so that it can be adjusted with respect thereto and at different distances therefrom. It also consists in a suspended wire frame, provided with bearings, in which rotate the curtain roller. It consists also in providing a novel detachable journal for the roller, whereby if a journal is injured or impaired it can be easily replaced.

47. Improved Button-hole Cutter.

This invention consists in arranging a cloth gauge within a circular slot of one scissor blade, which is shouldered, and a stop screw on the other slotted blade, which acts against the shoulder. When adjusted, a stop will prevent the blades from closing beyond the required point, so that all the button-holes will be of exactly the same length. The part of the scissors upon which the stop slides is provided with a scale of division marks for convenience in adjusting said stop.

48. Improved Shirt Bosom.

This invention consists in folding the cloth of which the bosoms are made in such manner as to re-enforce the portions between the plaits with one or two webs to strengthen it where it wears out soonest, and to do it without sewing on extra strips, as has been done in some cases. The single web is re-enforced between the plaits of a shirt bosom by means of narrow plaits formed of the cloth of which the wide plaits are made, and by overlapping the edges of the wide plaits.

49. Improved Belt Guide for Paper Machine.

The endless wire belt carriers of paper-making machinery are very difficult to keep in the true course on the rollers over which they are carried, owing to the variations of the tension caused by the shifting of the wires, and they cannot be kept in place by having the edges run against stationary guides, because the wires bend and double over at the edges and wear out rapidly. It is proposed, therefore, to have one of the bearings of one of the rollers arranged so that it can be shifted, so as to vary the tension at the edges of the belt, and provide mechanism in connection therewith, whereby the belt itself will cause the bearing to be shifted automatically whenever it runs out of its true course so as to correct it. Supposing the tension to be greatest on the left-hand side of the belt, by which it would be caused to run to the left and come in contact with a plate and move a bar in the same direction, the bell crank would be shifted thereby so as to move wheels towards the front, so that a blade would act on the front wheel and turn it so that a screw shaft would draw the bearing toward the front, which would lessen the tension on the left-hand side of the belt and prevent it from running in that direction. If the tension be greatest on the right-hand edge of the belt, the shaft would be shifted in the other direction, so that the blade would act on the other wheel and cause the screw to move the bearing in the other direction.

50. Improved Tooth-brush.

This invention consists of an ordinary tooth-brush having a convex brush arranged at the end of the handle, crosswise to it, in a different plane and fronting the other brush, so that, holding it by the end whereon the latter is arranged, and placing the convex brush in the mouth inside of the teeth, the convex form will apply to the concave wall of teeth in a manner calculated to brush the teeth at the inside more efficiently than can be done by the ordinary brushes.

51. Improved Apparatus for Treating Cane Juice.

The object of this invention is to construct an improved condensing machine for sugar plantations and chemical establishments, by which cane juice and molasses may be rapidly bleached without allowing the escape of sulphurous gases from the machine to the other parts of the building. By a fan wheel the required supply of gas is regulated, and the action of the same on the juice effected by a centrifugal or spray wheel in connection with a re-acting arch and absorbing shelves, producing a thorough contact of the gas with the greatest surface of juice.

52. Improved Saw-Filing Machine.

This invention has for its object to furnish an improved machine for use in filing saws, which will enable the saw to be filed quickly and accurately, and will render the operation of "striking" unnecessary. In using the machine the saw is secured in clamps, with its toothed edge projecting about one and a-quarter inches above said clamps, which are then placed upon the saw and another clamp. The guide frame is placed upon the clamps and the file handle is placed in the groove of the guide frame. The guide frame is adjusted to bring the file to the desired angle across the saw, and is secured in place by a set screw. The clamps are adjusted to bring the file to the first tooth, and the screw is tightened. The screws are adjusted to file the teeth to the desired depth. A rule is adjusted to bring the appropriate notch in the circular frame of the clamps to a division mark of the proper scale. After filing one side of the teeth, the machine is again adjusted, and the other side of the teeth is filed.

53. Improved Cloth Holder for Sewing Machines.

This invention has for its object to furnish a neat, simple, and convenient device for holding cloth while being sewn upon a sewing machine, to avoid the necessity of basting the work before sewing it. The invention consists of the device formed of a strip of thin sheet steel, made wider at one end and narrower at the other end, having a single bent point at its narrower end, two bent points at its wider end, and a short slot in its wider end, and bent so that its narrower end may be passed through the slot in its wider end, and the two ends may project parallel with each other.

54. Improved Saw Set.

This invention relates to an improved combination of parts or devices for setting teeth on both sides of the saw at the same time. To the opposite sides of the forward part of the handle are attached two plates, which are kept at the proper distance apart by a bar which also serves as a stop for the points of the saw teeth to rest against while using the machine. The saw teeth to be operated upon pass between two bars, one of which, when the machine is in use, is stationary, and may be adjusted according to the size of the saw teeth. The other bar is formed upon the side of the lower edge of a plate, to the upper part of which is attached a pin, which passes in through a hole in another plate, and rests against the inclined side of a cam wheel, so as, at the proper time, to clamp the saw against the bar while a tooth is being operated upon. The teeth are set by the punches, which pass in through holes in the forward parts of the bars, and which are so arranged as to operate upon two consecutive teeth and set them at the same time. The punches are forced in to set the teeth by the levers by the revolution of the cam wheel. The length of the feed may be adjusted according to the size of the teeth. By suitable mechanism, as each pair of teeth is set, the machinery is drawn forward into such a position as to operate upon the next pair of teeth. As described, the machine is designed to move along a saw secured in a vice; but, if desired, the machine may be inverted and secured in a vice, the saw moving along the machine as the teeth are set.

55. Improved Stamp for Crushing Ores.

The most essential part of this invention consists of a novel mode of operating stamps for crushing and pulverizing ores, &c., by a horizontal revolving cylinder, through which a series of bars, with a stamp head at each end, are arranged diametrically, so that they can slide endwise a short distance. The cylinder is arranged a suitable distance above the bottom of the bed containing the ore, and caused to revolve slowly; the stamps, as they approach the vertical line, slide in the cylinder and strike a blow on the ore, and are then forced around by the cylinder, and have a grinding or crushing effect. They strike two blows at each revolution. They are arranged as close together, both lengthwise and circumferentially, as they can be, and work well, and they strike a great number of blows to each revolution. Another part of this invention consists of a hollow cylindrical rotating ore holder, into which the ore is fed at one end and caused to work along slowly to the other end during the progress of the work, and discharge through holes on to a screen, which is arranged to separate the fine particles and carry the coarse portion back to the head of the ore holder, to be delivered into it again for reworking it. Another part of the invention consists of spiral ribs in the hollow revolving ore holder, to work the ore along the cylinder as it is gradually reduced by the stamps.

56. Improved Portable and Adjustable Hoisting Apparatus.

This invention has for its object to furnish an improved hoisting apparatus for tiering or stacking goods in storehouses, and which shall be so constructed that it may be readily moved from one part of the room to another and swung around to work in any desired position. To the stanchions of the room are attached one or more clamps which are so formed as to fit upon the stanchions. The clamps are hinged so that they can be readily detached from one stanchion and attached to another in some other part of the room. To a frame, made in U form, is pivoted the drum, around which the hoisting rope is wound, and to the ends of its journals are attached a larger and a smaller gear wheel. In the frame also works a shaft, to which are attached a smaller and a larger gear wheel, in such position that when one of the gear wheels meshes into the other the second pair will be out of gear, so that by sliding the shaft longitudinally the apparatus may be adjusted to work with speed or power, as may be desired. To the ends of the shaft are attached the cranks by which the power is applied. The frame may be swung around so as to work in various positions, as may be required in tiering the goods. In using the apparatus the rope from the drum is passed around the pulley of a block, which is connected with and supported from the joists or rafters by means of a clamp something like an ice tongs, so that the greater the weight of the package being handled, the firmer the said clamp may hold. With this apparatus the goods may be tiered rapidly and with a comparatively small amount of labour, the apparatus being readily adjusted as the position of the tiers may require.

57. Improved Reciprocating Churn.

This invention consists in the arrangement of perforated dashers, sliding in grooves within the churn, which are moved and operated against by similar perforated dashers fixed to a plunger rod passing through the sliding lid, which prevents the splashing of the cream.

58. Improved Skylight Bar.

This invention is an improvement in the class of skylight bars formed hollow or of sheet metal, and consists in forming the bar with a central vertically-projecting part, inclined side supports for the glass panes, and inclined gutters. The long and narrow shape of the bar is favourable to the admission of the light—more so than the bars with projecting gutters and parts. In a modification designed for lighter structures, the main support is bent of one or two pieces, and the gutter part projects sidewise instead of approaching toward the central axis.

59. Improved Combined Refrigerator and Beer Cooler.

This invention is designed to furnish an improved device, so constructed as to hold a beer cask and keep it cool, and which may also serve as a refrigerator for preserving various articles. The invention consists in the box provided with a cooling chamber, an ice-chamber, and one or more downwardly projecting recesses, projecting downward into the ice-chamber, which keep the cask and its contents cool until said contents may be wholly drawn off.

60. Improved Window Weather Strips.

This invention consists in providing the battens or vertical guide strips of sash windows with india-rubber strips set obliquely into the battens, to project with their opposite ends, and act like spring packing on the window sash. Suitable recesses in the battens allow the receding of the strips on opening or closing the windows.

61. Improved Door Spring.

This invention consists of a hollow vertical cylinder partly filled with liquid, and containing a piston with a valve which opens freely to allow the piston to rise unobstructedly when the door opens, and raises the arm of an elbow lever, to which the piston is connected by a rod, but which closes the passage, except a small orifice, when the door closes and forces the piston down, so that the closing of the door by a spring attached to the arm to which the piston is attached is retarded, so as to prevent slamming.

62. Improved Glove.

This invention consists, 1st, in a glove or gauntlet in which the bray back of the hand is formed or cut without fingers, and with which, in a gauntlet, the back or portions of the front of the wrist are all in one continuous piece of material. 2. A gauntlet, the front of whose wrist is gore-shaped, is so arranged and combined with the remaining portion of the wrist that, when folded or made, the seams are brought on the inside of the wrist. 3. A glove or gauntlet having the parts that form the palm and the front, back, and side portions of the fingers made of a separate piece or pieces from the body of the back. 4. A glove or gauntlet finger back composed of or wholly reinforced with leather when combined with a back composed of cloth or other textile fabric. 5. A glove or gauntlet in which those pieces, portions or parts that form the side of the palm and back portion of the fingers are connected, joined to and closed on the body of the back with a continuous stitched seam.

63. Improved Bee Hive.

This improvement relates, 1st, to a mode of preventing robber bees gaining access to the brood or honey chamber, and also entrapping them by means of adjustable

pivoted guides arranged in the bee entrance, and of a cage or prison placed at one side of the comb frames, both the guides and cage serving for other useful purposes in the ordinary economy of the hive when not thus utilized. 2. To providing the comb frames with removable guides, thus enabling the filled comb of one frame to be removed and transferred to an empty frame or to a box for transportation to market or elsewhere without removing the frame itself. 3. To a cloth or flexible guide plate for forming a division between comb frames, and thus compelling the bees to build comb the whole length of one frame instead of building it in one end of several adjacent frames, as they will often do if left to themselves. 4. To devices for closing the bee entrance, which are adapted to co-operate with the guide strips above mentioned.

64. Improved Washing Machine.

This invention is designed to furnish an improved washing machine in which the clothes are washed by being projected from end to end of the machine as it is rocked upon its pivots, the labour of rocking being lessened by a balance weight connected with it. To the sides and bottom of the box are attached ribs or cleats, against which the clothes are rubbed as they slide back and forth; and in one or both ends of the box are secured a number of plates, the upper edges of which are formed with rounded projections, gradually increasing in height toward the end of the box, and which are designed to catch upon the clothes and turn them over as the box is oscillated.

65. Improved Washing Machine.

In using the machine, levers are raised into an upright position, the clothes are inserted between the beaters, and the cover is closed. As the levers are lowered the beater moves forward, pressing the clothes against a forward beater, forcing the water and dirt out of said clothes and through the perforations of the said beater. As the levers are again raised the beater moves back for another stroke, and the forward beater is rocked, its upper edge moving rearward and its lower edge forward, so as to loosen and detach the clothes.

66. Improved Blasting Plug.

This invention consists in having the meeting edges of a hollow blasting plug made in sections, rabbit-jointed together to prevent the escape of the blast until it has nearly expended its force on the object to be blasted or wholly separated it. It is also proposed to provide the plug with strong spurs on the sides, to be forced into the wall of the hole of the object to be blasted, to prevent the plug from being forced endwise out of the hole.

67. Improved Table Castor, &c.

This invention relates to castors and analogous devices having a seat or holder that is allowed to rotate on its stand or support. It consists in converting nearly all the sliding friction which is usually created by the surface contact of the holder and the bolt into rolling friction, by making the guide tube bear against the bolt only at the top and causing the enlarged bottom to bear on the outside of the bearing plate that moves on and with subjacent anti-friction rolls. It consists also in a peculiar construction of the bearing plate to enable it to embrace and work against the outer side of the balls, whereby the plate itself is prevented altogether from contact with the bolt, and therefore from all sliding friction.

68. Improved Pump Valve.

This invention relates to the lower or check valve for pumps, which are liable to break off, to twist out of position, get out of shape, retain sand or grit, and become useless in a short time. The invention consists in constructing a valve with a series of wings to which is screwed a cap, while between the two is compressed a leather, rubber, gutta-percha, or other suitable packing, and in forming the valve seat upon a raised and tapering tube with a bottom flange.

69. Improved Extension Hat Brim.

For an extension sunshade attachment to hat brims, to be extended for use or folded back at will, it is proposed to have a wide annular piece of cloth, having an india-rubber cord sewn to the outer edge of the ordinary brim, and stationary arms projecting from a supporting ring at the base of the crown under the ordinary brim to the edge, with branched extension arms pivoted to them, so as to swing outward and engage with socket clips on the flexible cord to extend the brim. These clips, with which the extension arms connect detachably, engage with hooks at the base of the crown, when the extension brim is folded back under the principal brim, to hold it up close to the under side of the latter. At the same time the rubber cord shifts the edge of the reversed extension brim around the opening of the crown in a manner to dispose it completely and neatly when it is not required to have it extended. The same inventor has also patented a similar device, which consists of an annular extension brim of cloth, sewn to the outer edge of the permanent brim, with folding arms for extending it, which are mounted on sliding arms for moving them out or in for extending the brim more or less, and elastic straps on the extension brim, in combination with the sliding extension, to control the extension brim when not wholly extended. The sliding extension arms have spring catches combined with them in such manner as to hold them in any position to which they may be adjusted.

70. Improved Harrow.

This invention consists in constructing a harrow frame of longitudinal and cross pieces, the first on edge while the second are flat, and the first notched underneath so as to receive and brace the second. This forms a very strong, durable, and cheap harrow frame, which any farmer can construct for himself. The harrow may be made larger or smaller, according to the work for which it is designed; or two of them may be connected together for cultivating both sides of a row of plants at the same time.

71. Improved Plough.

This invention has for its object to furnish an improved attachment for ploughs, to roll down stubble and weeds, and hold them until turned under by the plough so as to wholly cover them and leave the ground clean. An iron roller revolves in the bent-down ends of a bar which extends along and parallel with the said roller. To the bar is attached another bar, the upper part of which is bent twice at right angles, or into U shape, to pass over the beam to keep it in place, and at the same time allow the roller to rise and fall to conform to the inequalities of the ground. Several holes are formed in the rear part of a brace-bar to receive the bolt that secures it, so that by shifting the said bolt from one to another of said holes the roller may be moved toward or from the plough to adapt it for use with short or long grass or weeds. A rod projecting forward and bent upward, rearward, and inward, is designed to prevent the stubble or weeds from falling down toward the ploughed land, so as not to be rolled down and held by the roller, and consequently not fully covered by the plough.

72. Improved Boot Blacking Kit.

This invention consists of an ordinary polishing brush with a blacking box attached to the back, and a daubing brush attached to the handle, so that all are collectively combined in one article, so as not to interfere with the use of the polishing brush, and thus preventing accidental separation and misplacement of either of the articles. The daubing brush is detachably connected to the handle of the polishing brush, so that it can be taken off to use.

73. Improved Traction Wheel.

This invention consists in the means for holding the rubber sections of a tire on the wheel, so that they will be held securely and yet be easily detachable. The solid plate or spoke wheel, of suitable metal, is provided with two projecting rims. The outer rim is flanged to keep the rubber in place, and the latter is of two or more pieces, placed around the periphery of the wheel. The rubber tire is firmly sustained on the wheels by guard-plates. By tightening the bolts in slots or holes in the rim, the rubber tire will curve out slightly between the interstices of the guard-plates, forming, instead of a polygonal, an almost circular periphery, avoiding thereby, in connection with the elastic washers, the noisy concussion of the old wheels. The breaking strain of the rubber tire is, by means of the strong support of the guard-plates, obviated, and the elastic material applied so as to give bearing surface and spring action against concussion.

74. Improved Metallic Clasp.

The object of this device is to furnish ready and convenient means for holding or supporting drawers or overalls when a button fails, for hanging up hats and other articles of clothing, or for supporting ladies' dresses, &c. The clasp is attached to the article by putting the teeth against the cloth to be fastened, when the slide is turned one side, and then back over the teeth. There is a slight spring to the slide, which holds it in place and makes the attachment secure. As manufactured for use, the clasp does not exceed the weight of an ordinary metal button.

75. Improved Harvester.

This invention has for its object to furnish an improved device by means of which the table or finger bar may be raised, when desired, by the advance of the machine, thus dispensing with the ordinary levers and keeping the machine free for the operation of the self rake.

76. Improved Self Closing Faucet.

This invention relates to improvements on faucets of the kind having swivel discharge tubes, which tubes, when in one position, are closed and stop the outflow of water, while in the other position they communicate with the water supply, are open, and allow the water to flow out. Whenever it is desired to have the water flow out, the horizontal tube is turned by hand to open the aperture, and is held so long as necessary; but as soon as this tube is let go, the pressure of water against another piston immediately causes the vertical tube to swing closed.

77. Improved Manufacture of Wadding.

It is proposed to manufacture waddings of old delaines, and other part cotton and part wool goods, by picking the stock into sufficiently fine and soft particles to form a soft, fine lap, and then passing it directly from the machine in which it is made through a bath composed of a solution of resin, caustic soda, and also colouring matter. The solution saturates the lap throughout and secures the fibre, so as to make as good and strong an article as the ordinary long fibre, and yet does not injure the fibre in respect to the light, crispy nature which it is necessary for all good waddings to possess. It is also proposed to apply a dressing of plaster of Paris to the surfaces of the wadding as it passes out of the bath, to glaze it and prevent it from sticking, by passing it between a couple of boxes containing the plaster, and brushes for throwing it on the wadding as it passes along. The claims cover both the manufactured article and the mechanism by which the wadding is made.

78. Improved Clothes Dryer.

The centrical vertical standard upon which the device for drying clothes revolves has feet pivoted to a sliding socket collar and braces. The braces are also at their upper ends pivoted to a similar socket collar, which moves loosely upon the vertical standard. The lower ends of the feet are made fast to the ground by suitable pins driven through loops. The number of braces is equal to the number of feet employed. A series of semi-vertical brace arms, which at their base are pivoted to a socket collar similar to those above described, forms a base for the drying apparatus. These brace arms are also at their upper ends pivoted to an equal number of radial arms, which also are at their inner ends pivoted to another similar socket collar. The whole series of arms are provided with a network of clothes-lines. Cords pass over pulleys, having their outer ends attached to one of the radial arms at opposite sides of the dryer, and are used to fold up the dryer like an umbrella.

79. Improved Device for Manufacturing Jewelry Bases.

This invention consists in a peculiarly constructed former combined with a die burnisher and mandrel. A blank has a bottom and barrel at a sharp angle to each other. The former is made in sections. The female die is made with a detachable bottom for convenience in removing the blank, and with a shoulder in its cavity, leaving a space around the barrel of the blank when said blank is inserted in said die. A plunger is made with a square edge, and a recess having a rounded angle. The former is placed in the blank and the blank is inserted within the shoulder of the die. The plunger is then brought down upon the edge of the barrel of the blank, turning the said edge inward over the former, producing the blank. The blank is now placed in a hollow mandrel, and while the mandrel is being rotated in a lathe, a burnisher is held against the turned-over edge, which is thus pressed down upon the former until it has a sharp angle. The blank is now taken out of the mandrel, and the middle section of the former is removed, and subsequently the others, after which the bottom is cut out so as to produce a blank which consists of three curved strips, two being horizontal, and the other, which connects them, vertical.

80. Improved Vice.

This invention has for its object to furnish an improved bench vice. Upon the inner ends of screws are secured small gear wheels, the teeth of which mesh into each other, so that by turning the right screw the left screw will be turned in the opposite direction, and the two screws will work together to carry the movable-jaw back and forth, exactly parallel with the stationary jaw.

81. Improved Iron Railway Tie.

This invention furnishes an improved cross tie and fastening for railroad rails, which shall support and firmly secure the rails in place. The invention consists in wrought iron ties for railroad tracks, having transverse flanges formed solid upon them to form grooves to receive the rails, and having holes formed through them to receive the clamps.

82. Improved Dies for Plain Finger Rings.

This invention is an improved device for enlarging and finishing plain finger rings. The lower or stationary die has a hole formed through it of such a size as to allow a plunger to pass through it freely. In the upper end of the hole is formed a rounded recess to receive the ring. The plunger is made tapering or conical, and with its upper part of exactly the size required for the ring. Upon the upper end of the plunger is formed a tenon to enter a hole in the lower end of the holder, by which the said plunger is forced through the ring. In using the device the ring is placed in the recess of the die, and the plunger is forced through it by the holder, bringing the ring to exactly the required size, and leaving it perfectly true. The same inventor has also patented an improved mode of making plain finger rings without a joint. The invention consists in two sets of dies for forming a jointless ring from a solid ring plate. The half-round ring plate is laid, rounded side downward, in the flaring upper end of the cavity of a die, and the plunger brought down upon it, which forces it into the lower part of the cavity of the die, giving it a somewhat conical form, and producing the conical ring. The latter is placed, larger edge downward, in the cavity of the die, and the tapering part of the plunger forced into it, which forces the smaller edge of the ring outward, while the taper of the cavity of the die forces its longer edge inward, and produces a ring convex upon its inner surface and half round upon its outer surface. The ring may then be finished, enlarged, and sized in the ordinary manner.

83. Improved Pencil Case.

This invention is an improvement in calendar pencil cases, and consists in providing the case with a perforated cap and a scale of lineal measurement, whereby the same is adapted to be applied to pencils of any length and to be used as a rule or measure in determining the length or other dimension of any object.

84. Improved Machine for Sawing Laths.

This invention consists of a gang of circular saws on a horizontal arbor, in different sizes, with an inclined table and feed rollers so arranged that lath and other like stuff may be sawn obliquely to the sides, to produce bevel-edged strips by saws on a horizontal arbor. The invention also consists of one or more feed rollers made slightly conical, and provided with spiral ribs arranged to force the piece to be sawn to the guide and keep it there, as well as to feed it to the saws.

85. Improved Glove Fastening.

This invention is intended to produce a new fastening for kid and other gloves, and it consists of a pin supported firmly by the projecting parts of a plate attached to one

side of the glove, which catches between coiled parallel springs of a plate attached to the other side of the glove, so that they, in combination with the action of the supporting side plate of the pin on the ends of the springs, firmly hold the parts together.

86. Improved Adjustable Scaffold.

For adjusting the scaffolds of wall plasterers and ceiling decorators, high or low, according to the height of the room, it is proposed to have short trestle heads mounted on three legs, with a vertically adjusting standard in each head, having a fastening to hold it at any height, and having a couple of plates clamped to it at each side near the top, so that they can be readily adjusted to form, with the standard, a T head whereon the scaffold boards may rest flatwise, when, as in the case of decorating ceilings, it is desirable to build broad scaffolds by laying the scaffold boards or planks extending from one trestle head to another, and arranged edgewise to support the scaffold boards. In order to pack the benches the legs are jointed to them so as to fold over on the sides. When in use the ends of the legs bear against the walls or shoulders of the notches, and so transmit the force directly from one to the other without injury to the joints.

87. Improved Invalid Bedstead.

This invention consists of an improved bedstead, which is so constructed that the head part of the bed bottom may be raised and lowered gently and gradually to any desired extent, so as to change the position of the person lying upon the bed. To the head parts of the slats is secured a cross bar, to the lower side of the ends of which are attached sockets to receive the upper ends of rods, the lower ends of which are pivoted to nuts, through which pass the end parts of another rod, upon one half of which is cut a right screw thread, and upon the other half a left screw thread, so that when the latter rod is turned in one direction the nuts may move toward each other, and when the said rod is turned in the other direction the said nuts may move from each other, thus lowering and raising the head part of the bed bottom as may be desired.

88. Improved Metal Window Sash.

This invention consists in making the oval headed T-shaped mouldings for show windows by first forming an oval or semi-elliptical bar of lead with a groove in the flat side for the base of the head of the moulding, by forcing the head through a die of suitable form in the manner of forming lead tubes. Second, in drawing the silver-plated cover of sheet metal upon the said lead bar, by forcing a flat strip of the covering metal and the lead bar through a die plate together. Third, in soldering the iron bar which constitutes the vertical portion of the T to the lead bar by heating one edge of the iron bar in a bath of solder and tinning it at the same time, and then laying the tinned and heated edge in the groove of the lead bar, whereby they become united, the iron bar heating the lead bar sufficiently to cause the union of the lead with the tinned surface of the iron when they become cool. Fourth, in making a cheap bar or moulding for inferior work, where the plated moulding will be too expensive, by uniting the lead and metal bars, as above described, without the plated metal covering for the lead bar.

89. Improved Paper File.

The object of this invention is to furnish an improved paper file for binding letters, bills, newspapers, pamphlets, sheet music, &c., in a simple, elegant, and quick manner, without tearing, defacing, or otherwise injuring the papers or documents. This invention consists of a square, round, or polygonal piece over which strings are longitudinally stretched in suitable manner, which, in connection with lateral binding strings placed over a grooved or recessed part of the main piece and a thread and needle, bind the sheets in a manner similar to that of binding books.

90. Improved Toy.

This invention is a toy for children, which will furnish not only amusement but exercise; and it consists in what is known as the "child's wheel runner" combined with a whistle, the wheel being made to operate and blow the whistle as the child propels it.

91. Improved Apparatus for Moistening the Atmosphere.

For moistening the atmosphere in weaving and other rooms, it is proposed to employ an atomizer, air chamber, and condensing pump, a water cistern, reservoir, and an automatic apparatus for supplying the cistern and the atomizer from the reservoir regularly and uniformly, to be expelled to the atmosphere by the air from the air pressure chamber, in which it is condensed by the pump. In combination with the reservoir and cistern is a filter to separate from the water any solid particles that might obstruct the pipes of the atomizer, also to purify it. The pump will, in practice, be run by power, and as many atomizers will be applied to one air chamber and cistern as may be demanded by the capacity of the room to be charged.

92. Improved Machine for Cutting Tobacco.

This invention has for its object to furnish an improved machine for cutting tobacco, the same being constructed with a single knife working upon inclined bearings, and operating with a sliding shear cut upon the tobacco, which is placed in a box with sides at right angles and bottom parallel with said knife.

93. Improved Die for Making Watch Case Caps and Backs.

This invention consists of a die of the usual form and material, but having, instead of a flat surface, an elevation, which gradually increases from the circumference toward the centre, adjusted to the elasticity of the gold and the thickness of the covers, producing a perfectly flat even plane, more accurate than if spun out. It is an important improvement in the manufacture of gold caps and backs to watches.

94. Improved Table Dish Stand.

The essential feature of the invention is a stand or tray for dishes, of which the top or plate is composed of metal with a porcelain cover or enamel, the enamel being to conceal the iron or give it a fine finish, and form the groundwork for fine picture ornamentation by the decalcomanic or other process.

95. Improved Stop Valve.

This invention relates to that class of stop valves in which two discs are arranged to move forward and backward at right angles to the water channel in a chamber through which the channel passes at openings on opposite sides whereat the seats are formed for the discs, and on which they are caused to press tightly when moved upon them.

96. Improved Washing Machine.

In using the machine, the clothes are placed upon a false bottom around a rotating vertical cylinder. The handle is grasped in the left hand to apply pressure, and a vertical roller, held between pivoted bars, to which the handle is attached, is revolved with the right hand by means of the crank. The cylinder holds the clothes out so that they will be in proper position to be operated upon by the roller, the flange of the said cylinder pushing the lower part of the clothes in beneath the mass, so that they will be continuously turning over. The outer part of the bottom as it is rotated by the roller moves faster than the inner part, so that the clothes will be rubbed as well as pressed.

97. Improved Water Elevator.

This invention consists of a stationary case in the form of a hollow inverted truncated cone, inside of which is a revolving inverted cone with one or more spiral flanges extending from bottom to top, and apparatus for revolving the inner cone for raising water short distances in large quantities, for draining purposes and the like.

98. Improved Pump.

This invention consists of a novel construction and mode of applying a bush or lining of glass or other hard and durable wearing substance in the pump cylinder or stock, to sustain the wear of the sucker or pump barrel.

99. Improved Floor.

The object of this invention is to provide means for strengthening floors, roofs, &c. and it consists in truss rods passed through the joists of the floor or rafters of a roof in combination with bridge blocks fitted between the joists on one or both sides of each rod. Nuts on the rod are turned up, giving the rod any required degree of tension, and binding the blocks and joists firmly together.

100. Improved Waste Removing Device for Carding Machines.

This invention consists of a brush and an endless carrier for it combined with the burr box of a carding machine, in such manner that it brushes out the burrs, and, by keeping it clear of them, prevents it from filling and the burrs from overflowing upon the main card.

101. Improved Furniture Spring.

This invention has for its object to furnish an improved spring for application to other parts of a chair, spring bed, or other piece of furniture where a yielding connection is required. Upon the lower side of one edge of two plates are formed inwardly projecting flanges, in which are formed a number of holes to receive the screws by which they are secured in place. In the plates are formed holes to receive the bar, which has a pin in a recess formed in the upper side. A rubber block, of any suitable form, is interposed between the plates, through which is a rod which forms the hinge, and which is provided with a nut to regulate the tension of the spring. The same inventor has also patented another form of chair spring, which consists in flanged plates hinged together by a transverse bolt passing through suitable lugs. An india-rubber block is placed beneath the axis of the hinge. These are only two patents out of more than one dozen applications, all of which have been granted to Mr. Doremus, through the Scientific American Patent Agency, within the past five weeks.

102. Improved Hay and Cotton Press.

This invention consists in an improvement of the operative mechanism for hay and cotton presses. A pair of long levers are pivoted at one end to strong posts near their upper ends, the said posts rising up from the platform a suitable distance from the front of the case. At the other ends said levers project through slots in the front of the case, and are connected by short links with the under side of the follower. These levers have a bar pivoted to them, the said bars being pivoted to the free ends of other levers, which at their other ends are pivoted to the platform and also to the bars. These latter bars are pivoted to the axis of the upper wheel of a pair of eccentric segmental wheels, arranged between posts, so that the said axis and a strong block above are caused to rise by the turning of the lower wheel to force up the follower. By the short movement of the upper wheel, due to the eccentricity of its face and that of the lower wheel whereon it rests, a long movement is imparted to the follower in consequence of the arrangement of the levers and the connections; and in the last part of the operation, when the resistance has greatly increased, a considerable measure of the power is transmitted through toggle-jointed bars, by which the leverage is so increased that the greatest force is obtained at the time it is most needed.

103. Improved Farm Gate.

This invention relates to gates which both turn and slide, and consists in the improved construction of the frame in which they slide. The gate when hung in the swivelled frames can be half opened, or more or less than half opened, by sliding it on the frames, and can then, or in any position on said frames, be turned and fastened at either end to the gate post.

104. Improved Twisting and Doubling Machine.

This invention relates to means by which the twister, flyer or spindle or twist plate of the twister and feed rolls of same twister or cord-making machine may be made to cease their operation automatically whenever a thread is broken or full number of ends ceases to be supplied to the rollers.

105. Improved Steam Engine Governor Valve.

The invention consists in the improvement of governor valves. Openings are made in the sides of the valves, which allow the steam to enter the chambers in the shells. There may be four of these openings and chambers, so as to balance the valve when it is made of large diameter. An arm is attached to the valve stem and connected to the governor, by means of which the valve is partially revolved. The valve is made slightly tapering in the shell, so that any wear may be taken up readily and the valve made steam-tight. The valve will work equally well in either direction, and the steam may enter and be discharged from either of the openings. Plug screws are provided, by the removal of either of which the position of the valve can be seen, so that it can be varied or set by sight. A small hole is made (one or more) in the top of the valve to equalize the pressure.

106. Improved Door Check.

This invention is an improvement in the class of devices adapted to be applied to doors for holding them open at any desired angle; and it consists in a pivoted catch lever, a notched circular plate, and a rod, all arranged to adapt the lever to be locked in various positions, and thereby hold the rod engaged with the floor.

107. Improved Sole Channelling and Heel Burnishing Machines.

The first invention consists in the improvement of machines for channelling the soles of boots and shoes. The pattern upon which the leather sole is laid to be channelled approximates nearly to the shape of the sole, so that soles varying somewhat in size and shape may be channelled on the same pattern. The edge of the pattern is a cogged rack, which gears with two small spur wheels, and is held in gear by means of a roll which bears against its inside. The roll revolves on a pin in a slide, which is forced up by a spiral spring, and the spur wheels are revolved by suitable means. For the removal of the pattern the roll and slide are forced back by means of a lever. A movable arm which projects over the bed may be moved laterally. A suitably arranged lever on the side of the arm carries a roller on its front end which bears upon the sole and keeps it down firm on the pattern. Attached to the back of the movable arm, by means of a hinge, is the adjustable guide, which is forced outward from the arm by a spiral spring, and bears against the edge of the sole as the pattern is revolved. By the pressure of the foot communicating motion to a cord, the arm is swung back for the removal of the pattern and placing the sole. The knife or channeller and the groover are also adjustably attached to the end of the roll lever. The knife and groover partake of the movement of the roller, and are raised and lowered by means of a cam lever. To operate with the machine, the cam lever, which lifts the knife, groover, and roll, is pressed down. Then, by pressing with the foot on the treadle, the arm is swung back, or to one side. The sole is then placed on the pattern and the treadle released, which allows the guide to press the sole. Then the lever, which throws down the roll and knife, is lifted, and by turning the crank the sole is revolved, and the channelling is completed. The top of the pattern is cross serrated, with spurs therein to hold the sole. The same inventor has also devised an improved machine for burnishing and polishing the heels of boots and shoes. The frame or bench consists of two stands and connecting plate. A spindle is hinge jointed, and slides in a threaded tube. The latter is adjustable in the socket of the stand, and clamped at any point of adjustment by a screw passing down through said socket. The spindle is in two parts, hinged together, so that one part can be turned on one side to facilitate the putting in and taking out the shoe. A hand wheel nut works over the externally threaded tube, and against a shoulder on the spindle, to force the latter forward into the shoe and the shoe against the heel piece. When the shoe is placed in the machine it is given a revolving motion of about two-thirds of a revolution by turning a crank, which can be increased or diminished, and the shoe turned more or less, as may be desired. The burnisher is adjustably attached to the end of a beam, to which is given a longitudinal motion. By bearing down on a suitably arranged treadle, the outer end of the box and burnishing beam are tipped down, which raises the burnisher from the heel. A cavity in the burnisher is connected by means of a hole with a gas-burner for heating the burnisher, if a high temperature is desired, but the burnisher is readily removed and heated and replaced, if required.